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APPENDIX 1

OVERVIEW OF THE TESTS

This Appendix contains tables summarizing the tests performed in the present study as well as the tests of Peter (1986).

The used variables are explained in the chapter *Notations*. If not especially mentioned, the characteristics were computed in the upstream reach (this applies e.g. for $h_{m,\ in,\ c}$, R_h, V_m, V^*, τ, θ, the different Froude and Reynolds numbers).

$S_{0,\ ini}$ is the initially built in bed slope (in tangential direction, along the axis of the channel).

h_1, h_2, h_{max} are the scour depth in the first, second scour hole and the maximum of them.

$\tan\beta_1$, $\tan\beta_2$, $\tan\beta_{max}$ are the maximum bed slopes in radial direction for the first and second scour and the maximum value.

ScLoc is the location of the scour.

The energy slope is given over three different areas: over the whole channel from the inlet to the outlet (from 4 m before to 4.6 m after the bend, $S_{e,\ all}$), over the domain equipped with macro-roughness (from 2 m before to 2 m after the bend, $S_{e,\ mr}$) and over the bend only (0° to 90°, $S_{e,\ bend}$).

The different characteristics were computed with d_{90} (at the final stage the bed surface was armored).

1.1 Table of basic test parameters

ID	$S_{0,ini}$ [%]	e_s [°]	e_d [mm]	Q_w [l/s]	Q_s [g/min]	Duration of test [h:min]	Measurements			Sediment sampling	
							Water L.	Bed T.	Velocity	Armor.	outlet
A1a	0.50%	none	-	120	-	0:45	-	X	(X)	-	X
A1b				130	100	2:00	-	X	-	-	X
A1c				140	800	2:50	-	X	(X)	-	X
A1d				150	1 500	0:50	-	-	-	-	X
A1e				170	4 400	3:30	-	X	(X)	-	X
A1f				212.5	5 000	1:40	-	X	-	-	X
A2a	0.50%	2°	20	140	800	2:00	-	X	-	-	X
A2b				170	4 400	5:35	-	X	(X)	-	X
A2c				212.5	5 000	2:15	-	X	(X)	-	X
B1b	0.50%	none	-	151	1 579	15:10	X	X	X	X	X
B1c				182	2 385	17:50	X	X	X	X	X
B1d				212	4 819	18:55	X	X	X	X	X
B2b	0.50%	4°	20	151	255	17:05	X	X	X	X	X
B2c				183	577	16:10	X	X	X	X	X
B2d				212	1 566	14:20	X	X	X	X	X
B3b	0.50%	2°	20	151	830	14:40	X	X	X	X	X
B3c				183	873	16:20	X	X	X	X	X
B3d				213	1 744	17:20	X	X	X	X	X
B4b	0.50%	1°	20	151	435	15:05	X	X	X	X	X
B4c				182	408	15:40	X	X	X	X	X
B4d				212	1 806	13:00	X	X	X	X	X
C1b	0.70%	none	-	151	3 831	12:50	X	X	X	X	X
C1c				182	6 077	12:00	X	X	X	X	X
C1d				211	7 975	16:15	X	X	X	X	X
C2b	0.70%	4°	20	154	2 336	13:10	X	X	X	X	X
C2c				182	2 355	14:00	X	X	X	X	X
C2d				212	4 388	15:40	X	X	X	X	X

Table 1.1: Basic test parameters (B = 1.00 m, R_c = 6.00 m, d_m = 8.5 mm, d_{90} = 14.8 mm, σ = 1.82, tanϕ = 0.754)

ID	$S_{0,ini}$ [%]	e_s [°]	e_d [mm]	Q_w [l/s]	Q_s [g/min]	Duration of test [h:min]	Measurements			Sediment sampling	
							Water L.	Bed T.	Velocity	Armor.	outlet
C3b	0.70%	2°	20	151	1 719	15:25	X	X	X	X	X
C3c				182	2 500	14:55	X	X	X	X	X
C3d				212	3 464	14:10	X	X	X	X	X
C4b	0.70%	1°	20	151	2 244	11:50	X	X	X	X	X
C4c				182	2 321	12:50	X	X	X	X	X
C4d				212	3 865	18:50	X	X	X	X	X
D1b	0.35%	none	-	151	693	16:10	X	X	X	X	X
D1c				183	875	24:15	X	X	X	X	X
D1d				211	1 309	18:30	X	X	X	X	X
D2b	0.35%	4°	20	150	303	14:20	X	X	X	X	X
D2c				181	767	17:15	X	X	X	X	X
D2d				211	1 236	17:55	X	X	X	X	X
D3b	0.35%	2°	20	150	298	14:45	X	X	X	X	X
D3c				180	184	17:25	X	X	X	X	X
D3d				211	647	17:50	X	X	X	X	X
D4b	0.35%	1°	20	150	385	15:20	X	X	X	X	X
D4c				181	159	18:25	X	X	X	X	X
D4d				211	1 295[1]	17:40	X	X	X	X	-
E2b	0.50%	4°	40	151	1 174	12:15	X	X	-	X	-
E2c				182	655	11:55	X	X	-	X	-
E2d				213	1 040	12:25	X	X	-	X	-
E3b	0.50%	2°	40	151	611	12:10	X	X	-	X	-
E3c				182	973	11:35	X	X	-	X	-
E3d				212	1 368	12:00	X	X	-	X	-
E5b	0.50%	8°	40	151	630	12:10	X	X	-	X	-
E5c				182	731	11:55	X	X	-	X	-
E5d				213	1 873	26:05	X	X	-	X	-

Table 1.1: Basic test parameters ($B = 1.00$ m, $R_c = 6.00$ m, $d_m = 8.5$ mm, $d_{90} = 14.8$ mm, $\sigma = 1.82$, $\tan\phi = 0.754$)

1.Computed with added sediments (at the inlet), since the outlet volume was not measured for this test.

1.2 Table 1 of measured and computed parameters

ID	$h_{m, in, c}$ [m]	R_h [m]	h_1 [m]	h_2 [m]	h_{max} [m]	$\tan\beta_1$ [-]	$\tan\beta_2$ [-]	$\tan\beta_{max}$ [-]	$ScLoc_1$ [°]	$ScLoc_2$ [°]	$S_{e, all}$ [%]	$S_{e, mr}$ [%]	$S_{e, bend}$ [%]
B1b	0.138	0.108	0.302	0.315	0.315	0.592	0.573	0.592	29	81	0.54%	0.70%	0.83%
B1c	0.162	0.122	0.339	0.467	0.467	0.654	1.100	1.100	31	92	0.58%	0.78%	0.74%
B1d	0.189	0.137	0.392	0.371	0.392	0.644	0.536	0.644	29	83	0.57%	0.73%	0.71%
B2b	0.156	0.119	0.258	0.251	0.258	0.401	0.292	0.401	44	90	0.61%	0.80%	0.77%
B2c	0.181	0.133	0.295	0.229	0.295	0.329	0.255	0.329	49	90	0.62%	0.89%	0.88%
B2d	0.196	0.141	0.319	0.316	0.319	0.594	0.378	0.594	30	71	0.66%	0.93%	0.96%
B3b	0.145	0.112	0.251	0.252	0.252	0.399	0.381	0.399	70	71	0.56%	0.79%	0.74%
B3c	0.178	0.131	0.303	0.281	0.303	0.456	0.466	0.466	60	89	0.63%	0.86%	0.84%
B3d	0.195	0.140	0.324	0.315	0.324	0.451	0.538	0.538	55	80	0.66%	0.91%	0.81%
B4b	0.146	0.113	0.240	0.217	0.240	0.249	0.238	0.249	64	87	0.53%	0.76%	0.69%
B4c	0.171	0.127	0.329	0.268	0.329	0.656	0.469	0.656	54	83	0.59%	0.85%	0.75%
B4d	0.196	0.141	0.425	0.494	0.494	0.631	0.655	0.655	55	71	0.62%	0.83%	0.77%
C1b	0.134	0.106	0.287	0.336	0.336	0.615	0.641	0.641	28	81	0.66%	0.80%	0.93%
C1c	0.151	0.116	0.321	0.417	0.417	0.625	0.694	0.694	29	88	0.63%	0.84%	0.89%
C1d	0.182	0.134	0.381	0.394	0.394	0.726	0.765	0.765	31	90	0.57%	0.77%	0.68%
C2b	0.141	0.110	0.261	0.219	0.261	0.362	0.216	0.362	41	89	0.75%	1.01%	1.01%
C2c	0.164	0.123	0.277	0.252	0.277	0.291	0.316	0.316	44	89	0.79%	1.11%	1.13%
C2d	0.190	0.138	0.271	0.267	0.271	0.312	0.409	0.409	41	71	0.74%	0.98%	1.05%
C3b	0.150	0.116	0.282	0.213	0.282	0.550	0.244	0.550	56	73	0.70%	1.00%	0.93%
C3c	0.160	0.121	0.291	0.240	0.291	0.576	0.306	0.576	41	90	0.75%	1.06%	1.03%
C3d	0.169	0.126	0.305	0.242	0.305	0.404	0.270	0.404	54	90	0.75%	1.01%	0.96%
C4b	0.146	0.113	0.306	0.194	0.306	0.691	0.247	0.691	53	99	0.74%	1.01%	0.88%
C4c	0.171	0.127	0.387	0.221	0.387	0.676	0.320	0.676	53	100	0.73%	0.97%	0.85%
C4d	0.189	0.137	0.414	0.368	0.414	0.703	0.477	0.703	54	71	0.62%	0.95%	0.81%
D1b	0.161	0.122	0.349	0.308	0.349	0.694	0.609	0.694	31	86	0.44%	0.61%	0.62%
D1c	0.180	0.132	0.335	0.310	0.335	0.628	0.427	0.628	26	89	0.48%	0.64%	0.64%
D1d	0.189	0.137	0.361	0.309	0.361	0.615	0.508	0.615	29	74	0.50%	0.66%	0.66%

Table 1.2: Table 1 of measured and computed parameters

ID	$h_{m, in, c}$ [m]	R_h [m]	h_1 [m]	h_2 [m]	h_{max} [m]	$\tan\beta_1$ [-]	$\tan\beta_2$ [-]	$\tan\beta_{max}$ [-]	$ScLoc_1$ [°]	$ScLoc_2$ [°]	$S_{e, all}$ [%]	$S_{e, mr}$ [%]	$S_{e, bend}$ [%]
D2b	0.151	0.116	0.260	0.219	0.260	0.518	0.237	0.518	44	89	0.53%	0.69%	0.58%
D2c	0.188	0.137	0.315	0.257	0.315	0.348	0.320	0.348	44	90	0.56%	0.79%	0.82%
D2d	0.207	0.146	0.357	0.285	0.357	0.422	0.311	0.422	44	74	0.59%	0.81%	0.89%
D3b	0.158	0.120	0.210	0.188	0.210	0.154	0.301	0.301	60	118	0.46%	0.57%	0.46%
D3c	0.183	0.134	0.290	0.259	0.290	0.435	0.442	0.442	54	90	0.56%	0.72%	0.65%
D3d	0.213	0.149	0.325	0.316	0.325	0.327	0.588	0.588	44	90	0.56%	0.79%	0.75%
D4b	0.165	0.124	0.217	0.199	0.217	0.269	0.164	0.269	53	100	0.50%	0.62%	0.54%
D4c	0.187	0.136	0.327	0.286	0.327	0.368	0.404	0.404	44	92	0.51%	0.71%	0.63%
D4d	0.203	0.145	0.328	0.284	0.328	0.421	0.477	0.477	29	86	0.54%	0.76%	0.69%
E2b	0.139	0.109	0.314	0.219	0.314	0.657	0.233	0.657	46	90	0.63%	0.89%	0.74%
E2c	0.168	0.126	0.304	0.289	0.304	0.458	0.542	0.542	36	74	0.66%	0.91%	0.94%
E2d	0.197	0.141	0.343	0.363	0.363	0.428	0.577	0.577	44	91	0.70%	0.92%	0.94%
E3b	0.157	0.119	0.267	0.280	0.280	0.361	0.454	0.454	44	94	0.62%	0.85%	0.83%
E3c	0.180	0.132	0.304	0.305	0.305	0.368	0.498	0.498	46	89	0.67%	0.95%	0.88%
E3d	0.187	0.136	0.309	0.323	0.323	0.353	0.588	0.588	44	94	0.70%	1.02%	0.92%
E5b	0.161	0.122	0.274	0.227	0.274	0.362	0.409	0.409	44	89	0.61%	0.78%	0.72%
E5c	0.177	0.131	0.296	0.289	0.296	0.393	0.423	0.423	44	89	0.65%	0.90%	0.91%
E5d	0.191	0.138	0.291	0.343	0.343	0.445	0.620	0.620	41	89	0.67%	1.00%	0.92%

Table 1.2: Table 1 of measured and computed parameters

1.3 Table 2 of measured and computed parameters

ID	V_m [m/s]	V* [m/s]	$Vol_{e,1}$ [m³]	$Vol_{e,2}$ [m³]	$Vol_{d,1}$ [m³]	$Vol_{d,2}$ [m³]	τ [kN/m²]	θ [-]	Fr [-]	Fr_d [-]	Fr* [-]	Re [-]	Re* [-]
B1b	1.099	0.105	0.237	0.244	0.132	0.046	11.1	0.047	0.946	2.256	0.217	8 648	1 186
B1c	1.127	0.123	0.221	0.381	0.169	0.058	15.2	0.064	0.895	2.313	0.253	11 450	1 387
B1d	1.125	0.124	0.264	0.316	0.125	0.044	15.3	0.064	0.827	2.308	0.254	12 860	1 389
B2b	0.972	0.119	0.176	0.211	0.107	0.014	14.1	0.060	0.787	1.995	0.244	10 722	1 338
B2c	1.009	0.111	0.223	0.218	0.167	0.009	12.3	0.052	0.758	2.072	0.228	11 201	1 248
B2d	1.080	0.120	0.235	0.251	0.161	0.017	14.4	0.061	0.778	2.217	0.246	12 849	1 350
B3b	1.045	0.100	0.186	0.207	0.129	0.028	10.1	0.043	0.878	2.145	0.206	8 561	1 130
B3c	1.026	0.122	0.246	0.226	0.164	0.018	14.9	0.063	0.775	2.105	0.250	12 187	1 372
B3d	1.092	0.137	0.217	0.233	0.130	0.035	18.9	0.080	0.791	2.242	0.282	14 626	1 545
B4b	1.034	0.092	0.127	0.162	0.096	0.041	8.4	0.035	0.864	2.123	0.188	7 862	1 029
B4c	1.062	0.112	0.263	0.202	0.139	0.029	12.5	0.053	0.820	2.179	0.230	10 842	1 259
B4d	1.079	0.117	0.432	0.218	0.156	0.003	13.7	0.058	0.777	2.215	0.240	12 556	1 317
C1b	1.127	0.113	0.219	0.232	0.137	0.040	12.8	0.054	0.982	2.312	0.232	9 080	1 271
C1c	1.200	0.116	0.239	0.407	0.147	0.028	13.4	0.056	0.985	2.462	0.238	10 217	1 302
C1d	1.157	0.130	0.303	0.331	0.161	0.037	16.8	0.071	0.866	2.376	0.266	13150	1 458
C2b	1.091	0.117	0.182	0.238	0.119	0.014	13.8	0.058	0.927	2.239	0.241	9 829	1 321
C2c	1.109	0.121	0.201	0.271	0.115	0.012	14.6	0.062	0.876	2.277	0.248	11 340	1 361
C2d	1.114	0.132	0.180	0.271	0.145	0.026	17.4	0.073	0.815	2.286	0.271	13 840	1 485
C3b	1.004	0.115	0.212	0.240	0.116	0.004	13.2	0.056	0.827	2.062	0.236	10 104	1 294
C3c	1.133	0.119	0.212	0.270	0.114	0.012	14.1	0.059	0.903	2.326	0.243	10 943	1 333
C3d	1.254	0.124	0.242	0.252	0.153	0.008	15.3	0.064	0.973	2.573	0.254	11 883	1 391
C4b	1.036	0.117	0.217	0.159	0.135	0.018	13.6	0.057	0.866	2.126	0.240	10 006	1 312
C4c	1.062	0.120	0.292	0.152	0.120	0.005	14.4	0.061	0.820	2.179	0.246	11 629	1 350
C4d	1.125	0.122	0.409	0.258	0.104	0.000	15.0	0.063	0.827	2.309	0.251	12 734	1 377
D1b	0.940	0.097	0.211	0.236	0.152	0.034	9.3	0.039	0.748	1.929	0.198	8 934	1 087
D1c	1.017	0.103	0.319	0.237	0.188	0.043	10.7	0.045	0.765	2.087	0.212	10 410	1 164
D1d	1.116	0.119	0.275	0.223	0.184	0.032	14.1	0.059	0.820	2.291	0.243	12 350	1 333

Table 1.3: Table 2 of measured and computed parameters

ID	V_m [m/s]	V* [m/s]	$Vol_{e,1}$ [m³]	$Vol_{e,2}$ [m³]	$Vol_{d,1}$ [m³]	$Vol_{d,2}$ [m³]	τ [kN/m²]	θ [-]	Fr [-]	Fr_d [-]	Fr* [-]	Re [-]	Re* [-]
D2b	0.995	0.110	0.228	0.143	0.175	0.015	12.1	0.051	0.817	2.042	0.226	9 703	1 238
D2c	0.961	0.108	0.219	0.225	0.139	0.022	11.6	0.049	0.708	1.973	0.221	11 179	1 212
D2d	1.018	0.111	0.216	0.252	0.158	0.033	12.4	0.052	0.714	2.089	0.228	12 361	1 250
D3b	0.950	0.099	0.087	0.080	0.058	0.017	9.7	0.041	0.762	1.949	0.203	9 009	1 110
D3c	0.985	0.121	0.208	0.183	0.134	0.021	14.6	0.061	0.734	2.021	0.248	12 297	1 357
D3d	0.991	0.127	0.205	0.247	0.125	0.032	16.1	0.068	0.685	2.033	0.260	14 379	1 425
D4b	0.910	0.100	0.093	0.101	0.063	0.026	9.9	0.042	0.715	1.867	0.204	9 389	1 120
D4c	0.965	0.114	0.215	0.173	0.087	0.040	12.9	0.054	0.713	1.981	0.233	11 758	1 278
D4d	1.037	0.119	0.272	0.195	0.121	0.032	14.2	0.060	0.734	2.127	0.244	13 076	1 338
E2b	1.081	0.123	0.288	0.215	0.155	0.016	15.2	0.064	0.924	2.218	0.253	10 202	1 385
E2c	1.083	0.127	0.307	0.294	0.132	0.007	16.2	0.068	0.843	2.224	0.261	12 191	1 433
E2d	1.083	0.142	0.312	0.283	0.216	0.022	20.2	0.085	0.780	2.223	0.291	15 221	1 597
E3b	0.964	0.114	0.208	0.223	0.146	0.016	13.0	0.055	0.777	1.978	0.234	10 331	1 282
E3c	1.011	0.129	0.258	0.240	0.172	0.024	16.6	0.070	0.761	2.075	0.264	12 953	1 449
E3d	1.136	0.134	0.297	0.260	0.160	0.017	18.0	0.076	0.840	2.332	0.276	13 869	1 510
E5b	0.938	0.114	0.220	0.176	0.115	0.009	13.0	0.055	0.746	1.925	0.234	10 559	1 283
E5c	1.028	0.119	0.254	0.278	0.107	0.025	14.3	0.060	0.779	2.109	0.245	11 874	1 343
E5d	1.113	0.123	0.276	0.261	0.099	0.027	15.1	0.064	0.813	2.284	0.252	12 901	1 381

Table 1.3: Table 2 of measured and computed parameters

1.4 Tests of Peter (1986)

ID	Q_w [l/s]	Q_s [g/min]	B [m]	R_c [m]	d_m [mm]	d_{90} [mm]	σ [-]	tanφ [-]
P01	10	90	0.50	1.75	1.7	2.0	1.19	0.727
P02	10	300	0.50	1.75	1.7	2.0	1.19	0.727
P03	14	90	0.50	1.75	1.7	2.0	1.19	0.727
P06	5	180	0.50	1.75	1.7	2.0	1.19	0.727
P07	10	180	0.50	1.75	1.7	2.0	1.19	0.727
P10	20	90	0.50	1.75	3.9	5.0	1.25	0.727
P11	10	90	0.50	1.75	3.9	5.0	1.25	0.727
P13	15	90	0.50	1.75	3.9	5.0	1.25	0.727
P14	20	270	0.50	1.75	3.9	5.0	1.25	0.727
P15	15	360	0.50	1.75	3.9	5.0	1.25	0.727
P23	15	180	0.50	1.75	2.0	4.6	3.21	0.839
P24	20	360	0.50	1.75	2.0	4.6	3.21	0.839
P25	15	360	0.50	1.75	2.0	4.6	3.21	0.839
P26	10	90	0.50	1.75	2.0	4.6	3.21	0.839
P27	10	270	0.50	1.75	2.0	4.6	3.21	0.839
P28	5	90	0.50	1.75	2.0	4.6	3.21	0.839
P30	20	180	0.50	1.75	2.0	4.6	3.21	0.839
P32	15	90	0.50	1.75	5.1	7.7	1.43	0.810
P33	20	180	0.50	1.75	5.1	7.7	1.43	0.810
P34	15	360	0.50	1.75	5.1	7.7	1.43	0.810
P35	12	180	0.50	1.75	5.1	7.7	1.43	0.810
P36	25	270	0.50	1.75	5.1	7.7	1.43	0.810
P37	25	90	0.50	1.75	5.1	7.7	1.43	0.810
P38	30	180	0.50	1.75	5.1	7.7	1.43	0.810
P39	19	288	0.80	1.60	5.1	7.7	1.43	0.810
P40	48	288	0.80	1.60	5.1	7.7	1.43	0.810
P41	40	144	0.80	1.60	5.1	7.7	1.43	0.810
P42	24	288	0.80	1.60	2.0	4.6	3.21	0.839
P43	32	288	0.80	1.60	2.0	4.6	3.21	0.839
P44	40	288	0.80	1.60	2.0	4.6	3.21	0.839
P45	20	0	0.80	1.60	2.0	4.6	3.21	0.839
P46	20	90	0.80	1.60	2.0	4.6	3.21	0.839

Table 1.4: Basic test parameters - Tests of Peter (1986)

ID	$h_{m, in, c}$ [m]	R_h [m]	h_1 [m]	h_2 [m]	$\tan\beta_1$ [-]	$\tan\beta_2$ [-]	$ScLoc_1$ [°]	$ScLoc_2$ [°]	$S_{e, all}$ [%]	$S_{e, bend}$ [%]
P01	0.045	0.038	0.153	0.139	0.850	0.800	39	114	0.45%	0.36%
P02	0.041	0.035	0.238	0.165	0.800	0.750	45	124	0.66%	0.61%
P03	0.059	0.048	0.189	0.147	0.900	0.950	40	103	0.33%	0.32%
P06	0.024	0.022	0.113	0.092	0.750	0.900	45	120	0.79%	0.80%
P07	0.043	0.036	0.181	0.178	0.750	0.800	41	122	0.55%	0.50%
P10	0.062	0.050	0.217	0.217	0.800	0.800	34	99	0.87%	0.66%
P11	0.034	0.030	0.223	0.125	1.000	0.700	25	93	1.38%	0.94%
P13	0.047	0.040	0.181	0.172	1.000	0.900	35	105	1.19%	1.07%
P14	0.060	0.049	0.231	0.185	1.100	0.750	37	104	0.86%	0.81%
P15	0.044	0.037	0.282	-	0.950	-	33	-	1.31%	1.05%
P23	0.053	0.044	0.163	0.168	0.600	0.700	58	126	0.75%	0.74%
P24	0.064	0.051	0.172	-	0.600	-	67	-	0.61%	0.51%
P25	0.053	0.044	0.154	0.153	0.700	0.750	55	118	0.71%	0.69%
P26	0.038	0.033	0.127	0.141	0.500	0.800	57	110	0.99%	0.89%
P27	0.039	0.034	0.119	0.162	0.500	0.800	42	95	0.88%	0.96%
P28	0.023	0.021	0.109	-	1.100	-	57	-	1.22%	1.22%
P30	0.066	0.052	0.172	0.188	0.600	0.550	47	116	0.61%	0.55%
P32	0.041	0.035	0.184	0.167	1.050	1.200	31	104	1.68%	1.47%
P33	0.054	0.045	0.212	0.186	0.750	1.000	37	110	1.54%	1.46%
P34	0.042	0.036	0.306	0.143	1.100	0.700	30	102	1.77%	1.66%
P35	0.033	0.029	0.178	0.193	0.800	0.900	36	95	2.18%	1.77%
P36	0.065	0.051	0.211	0.208	0.800	1.050	42	116	1.05%	0.95%
P37	0.068	0.053	0.213	0.235	0.950	0.650	36	132	1.16%	0.90%
P38	0.072	0.056	0.254	0.207	1.000	0.950	33	113	0.96%	0.87%
P39	0.039	0.035	0.179	0.160	1.300	1.400	36	109	1.91%	1.61%
P40	0.071	0.060	0.278	0.238	0.800	1.000	39	134	1.16%	0.98%
P41	0.063	0.054	0.252	0.216	0.850	1.450	47	124	1.20%	1.02%
P42	0.052	0.046	0.165	0.188	0.850	1.200	35	99	0.73%	0.60%
P43	0.063	0.055	0.215	0.220	0.650	1.400	56	130	0.75%	0.48%
P44	0.078	0.065	0.223	0.250	1.000	1.600	71	119	0.60%	0.41%
P45	0.049	0.044	0.153	0.171	0.700	0.900	73	131	0.62%	0.53%
P46	0.046	0.041	0.175	0.170	0.900	0.850	73	125	0.76%	0.60%

Table 1.5: Table 1 of measured and computed parameters - Tests of Peter (1986)

ID	V_m [m/s]	V* [m/s]	θ [-]	Fr [-]	Fr_d [-]	Fr* [-]	Re [-]	Re* [-]
P01	0.441	0.045	0.062	0.66	2.66	0.247	1 299	67.6
P02	0.486	0.052	0.083	0.76	2.93	0.287	1 390	78.6
P03	0.475	0.044	0.061	0.62	2.86	0.246	1 603	67.2
P06	0.419	0.043	0.058	0.87	2.53	0.239	713	65.3
P07	0.470	0.048	0.071	0.73	2.83	0.266	1 322	72.6
P10	0.643	0.073	0.066	0.82	2.56	0.256	2 759	277.0
P11	0.590	0.068	0.058	1.01	2.32	0.240	1 563	259.1
P13	0.639	0.074	0.068	0.94	2.54	0.260	2 225	281.2
P14	0.664	0.071	0.064	0.86	2.64	0.251	2 632	271.3
P15	0.681	0.075	0.071	1.04	2.71	0.265	2 141	286.1
P23	0.568	0.062	0.052	0.79	3.15	0.228	2 060	217.1
P24	0.630	0.062	0.052	0.80	3.49	0.226	2 380	215.7
P25	0.570	0.061	0.050	0.79	3.16	0.223	2 014	212.5
P26	0.531	0.061	0.050	0.87	2.94	0.222	1 512	211.8
P27	0.518	0.058	0.046	0.82	2.84	0.213	1 490	202.7
P28	0.436	0.052	0.037	0.92	2.42	0.192	835	183.2
P30	0.607	0.063	0.053	0.75	3.37	0.230	2 488	219.2
P32	0.730	0.082	0.055	1.15	2.54	0.233	2 210	482.1
P33	0.735	0.091	0.067	1.01	2.56	0.257	3 079	530.7
P34	0.723	0.085	0.059	1.12	2.50	0.241	2 316	497.9
P35	0.721	0.084	0.058	1.26	2.51	0.239	1 885	493.8
P36	0.773	0.082	0.054	0.97	2.69	0.231	3 191	478.0
P37	0.741	0.088	0.063	0.90	2.56	0.249	3 571	514.9
P38	0.841	0.082	0.055	1.00	2.92	0.233	3 477	481.0
P39	0.613	0.085	0.059	0.99	2.13	0.242	2 293	499.1
P40	0.857	0.090	0.065	1.01	2.94	0.255	4 119	526.0
P41	0.800	0.086	0.060	1.02	2.78	0.243	3 528	502.6
P42	0.580	0.061	0.050	0.81	3.22	0.223	2 122	212.9
P43	0.635	0.068	0.063	0.81	3.52	0.250	2 820	238.0
P44	0.644	0.068	0.062	0.74	3.58	0.247	3 334	235.9
P45	0.511	0.055	0.041	0.73	2.83	0.201	1 824	191.6
P46	0.542	0.059	0.047	0.80	3.00	0.215	1 851	205.2

Table 1.6: Table 2 of measured and computed parameters - Tests of Peter (1986)

APPENDIX 2

DATA ACQUISITION, DATA TREATMENT AND PROTOCOLS

This Appendix gives informations on

- the measurement devices,
- the principle of the data acquisition system,
- the main steps of the data treatment,
- the used protocols,
- observed special phenomena and events during the tests.

2.1 Technical data of the acquisition devices

2.1.1 Ultrasonic gauge

The used ultrasonic gauge (UNAM 30I9001) had the following technical specifications:

PRODUCER	BAUMER ELECTRIC, FRAUENFELD, SWITZERLAND
Measurement domain - distance	100...700 mm
Opening angle	10°
Frequency of sound	230 kHz
Resolution	< 0.3 mm
Temperature - drift	< 2% of distance to object
Working temperature	0...60°C

Table 2.1: Technical specifications ultrasonic gauge

2.1.2 Ultrasonic velocity profiler (UVP)

Transducers TN2-10-13 ()

Producer	Metflow SA, Lausanne, Switzerland
Transducer (length; diameter)	60; 13 mm
Active diameter	10 mm
Measurement domain - distance	5...1500 mm, (* 300 mm)
Near field length in water, c=1480 m/s	22 mm
Far field divergence	2.7
Opening angle	4.4° (2 x 2.2°)
Emission frequency	2 MHz
Sampling (= recording) frequency	35...230 Hz (* 77 Hz)
Resolution (in beam direction)	0.7...10 mm/s depending on the depth of the measurement domain * 3.6 mm/s in beam direction 14.0 mm/s in flow direction

Table 2.2: Technical specifications of the used UVP-transducers
** designates the most frequently used values; meas. depth = 30 cm*

see also Metflow: Users Monitor UVP-XW - Users Guide, Release 2, November 1st, 2000

List of used transducers

Transducer number (2 MHz)	Number on experimental setup
0981.0141	2
0981.0142	4
0981.0148	5
0981.0149	8
0981.0150	7
0981.0151	1
0981.0152	3
0981.0153	9
0981.0154	6

Table 2.3: List of used transducers

Velocity Monitor

Producer	Metflow SA, Lausanne, Switzerland
Monitor Version	UVP XW 3-PSi with external multiplexer
Program Version	UVP-XW 1.1b
Emitting frequency	1, 2, 4 MHz
Emitting voltage on transducer	30, 60, 90, 150 V (at 50Ω)
Emitting cycles per pulse	2 to 32
Pulse repetition frequency	990 to 7400 Hz
Number of channels	128
Receiving amplification	exponential
Space resolution (longitudinal)	~0.5 μs
Channel distance	variable, lowest possible: 0.37 mm
Velocity resolution	1/256 of maximum velocity
Repetition rate (emissions per profile)	8 to 240
Acquisition time per profile	minimum 4ms
Time delay between profiles	0 to 65’000 ms

Table 2.4: Technical specifications of the Ultrasonic Velocity Profiler Monitor

2.2 *Data acquisition*

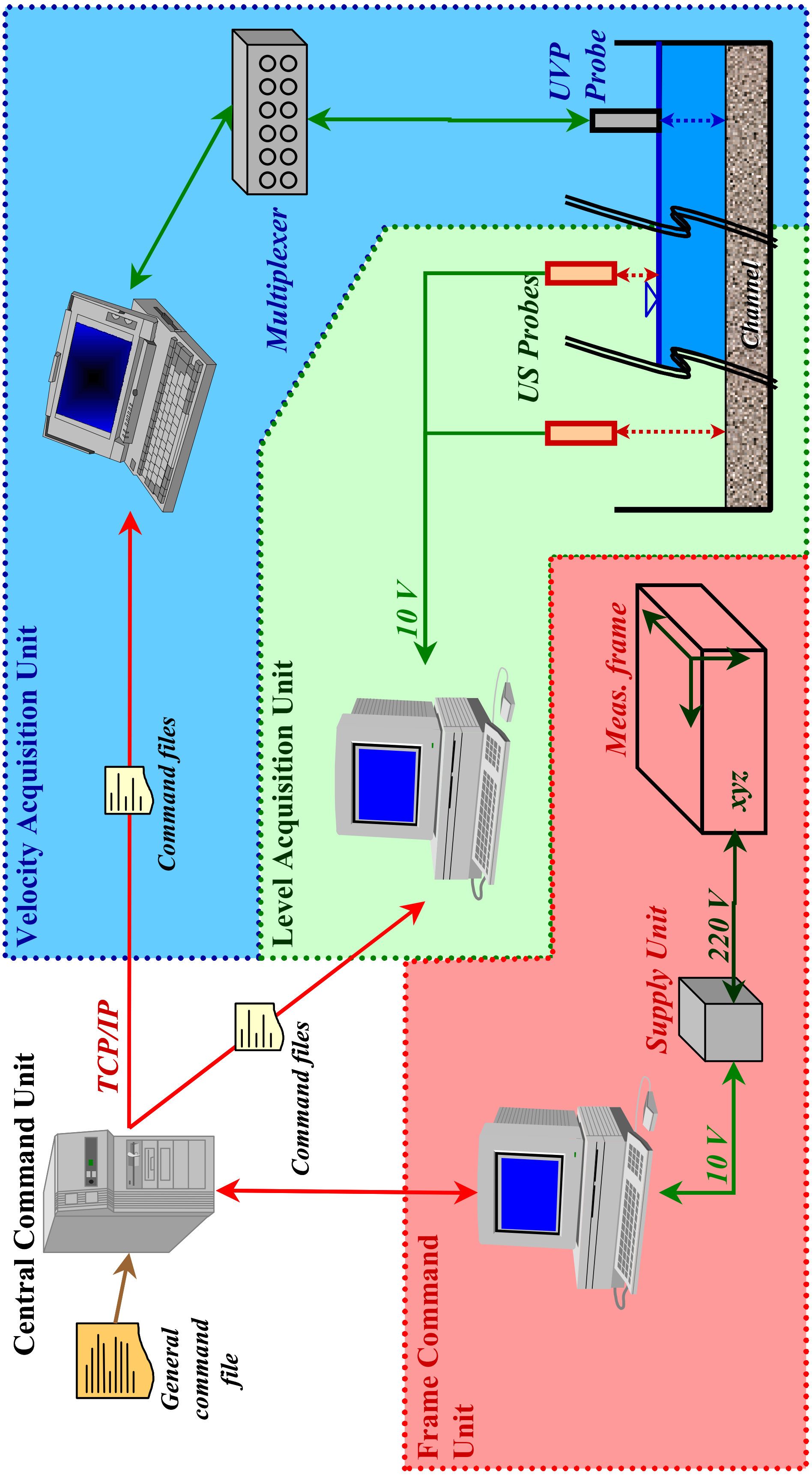
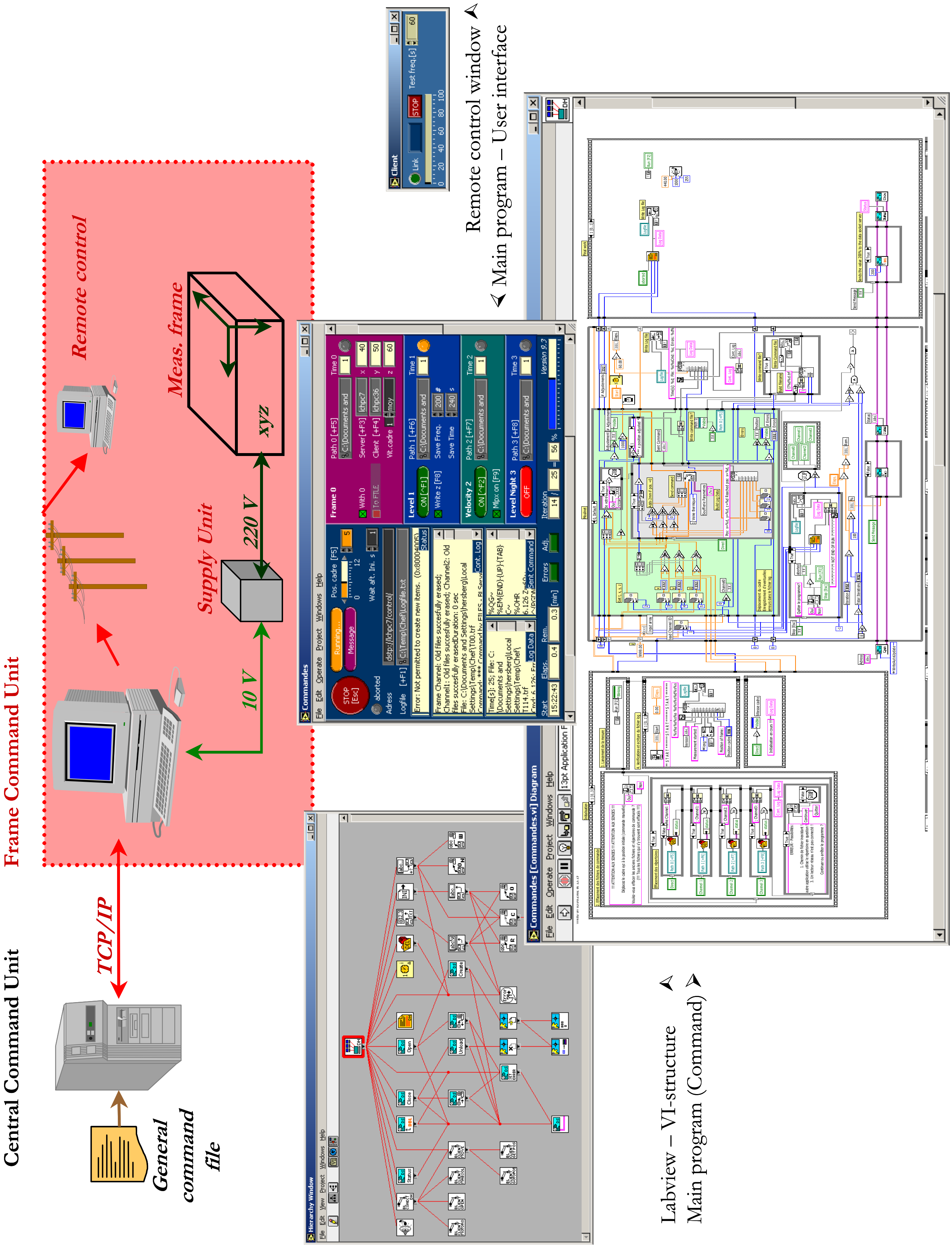
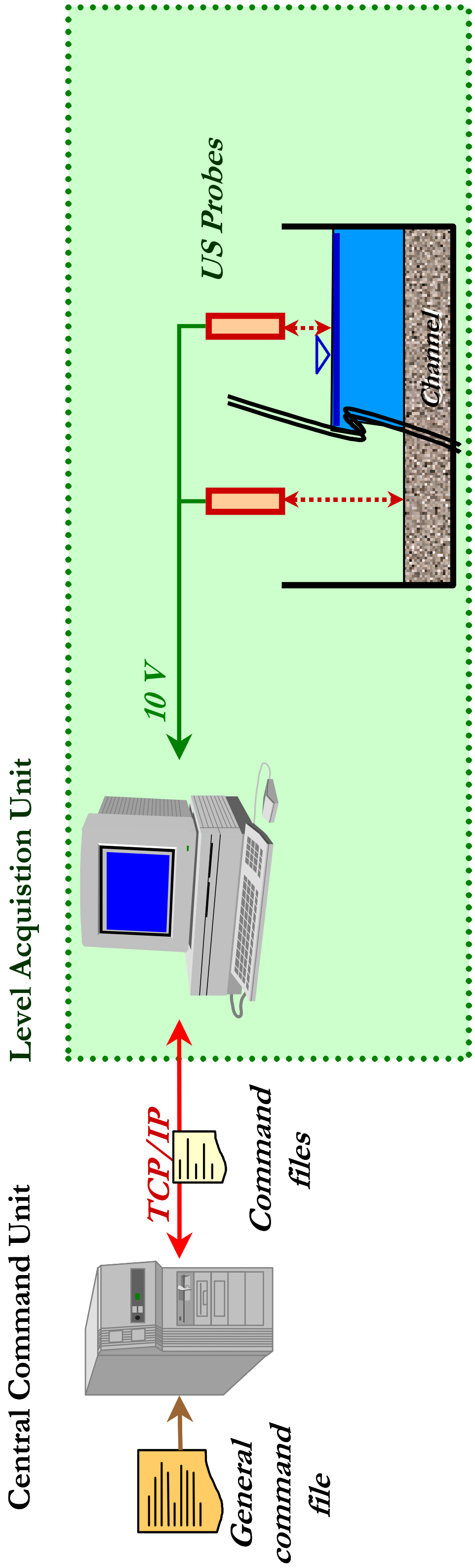


Figure 2.1: Overview of the data acquisition devices

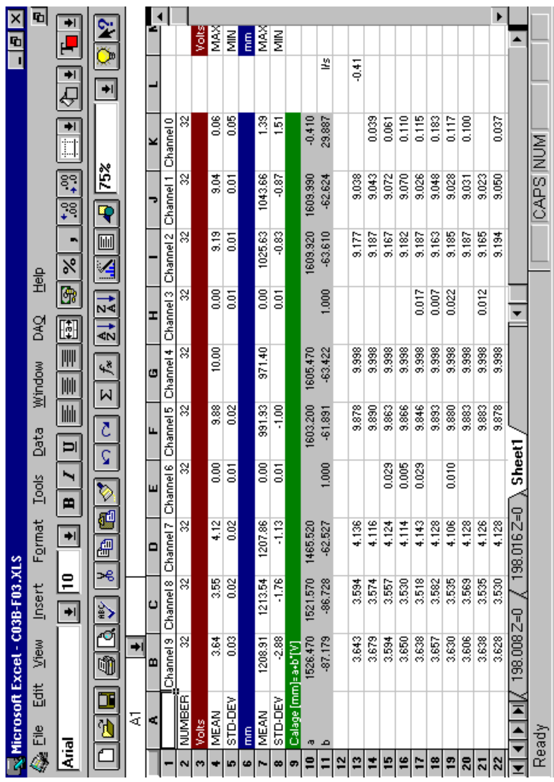
2.2.1 Frame command unit



2.2.2 Water and bed levelling unit

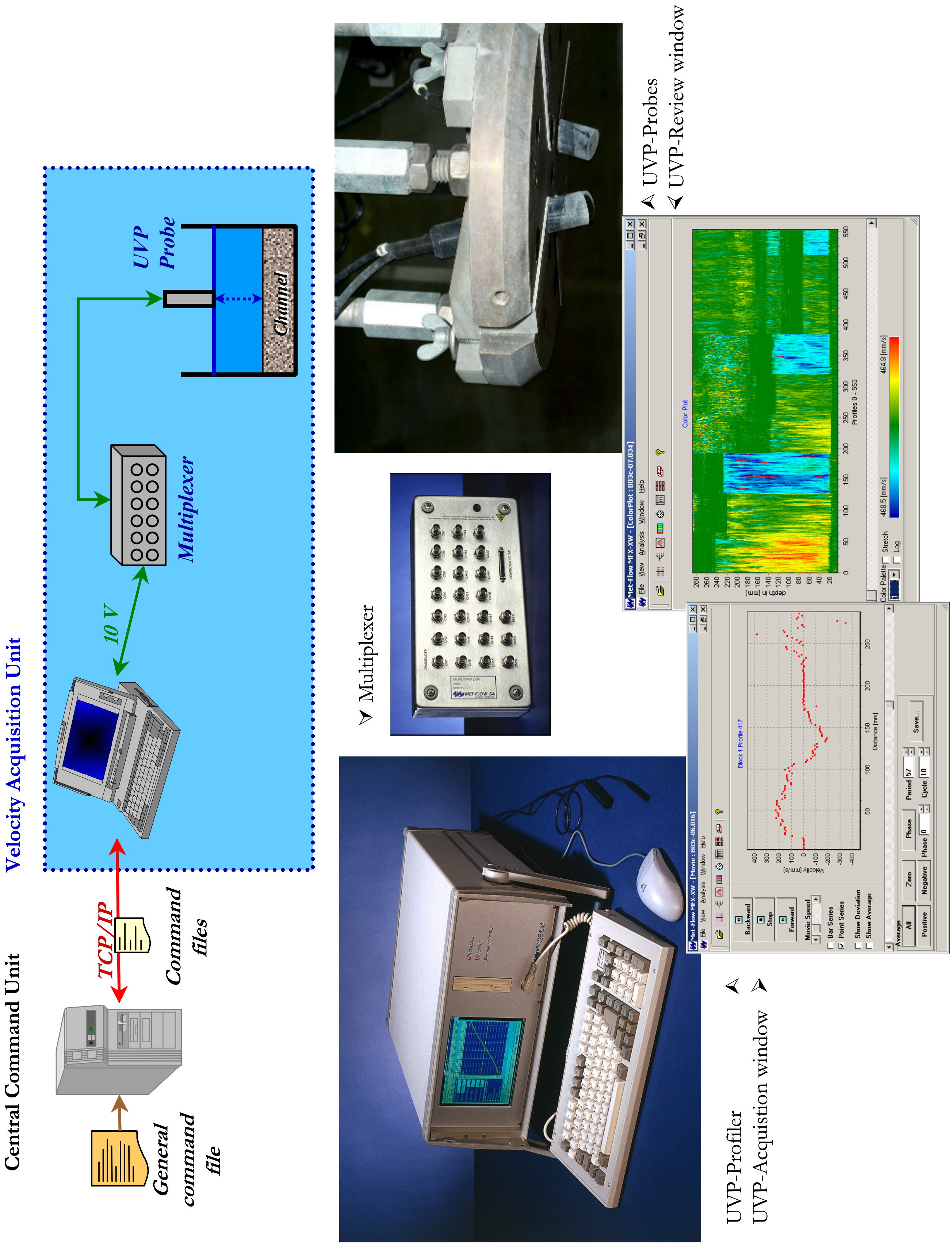


Ultrasonic measurement probe



Acquistion window

2.2.3 Velocity measurement unit



2.3 *Sample protocols*

Test protocole **Date** ________ **ID** ________ *)

PAGE 1

Main characteristics

Jf [%] ________ Qe [l/s] ________

Qs [g/s] ________

Type of test

- ❑ Armouring
- ❑ Test

Macroroughness

- ❑ Without ❑ Prismat.
- ❑ spacing ___ ❑ ________
- ❑ At the outlet ________

Computer / Files

Command water level	.txt		
Command bed level	.txt		
Command velocity	.txt		
Log	.txt	(Name=ID)	(B01a)
Water level	-E___.xls	(Name=ID+E+Pos_frame)	(B01a-E04)
Bed level	-F___.xls	(Name=ID+F+Pos_frame)	(B01a-F04)
Velocity	.*	(Name=ID+Pos_frame)	(B01a-04)

Progress

	Work		Time [h:min]	Qs [g/min]
	Preparation			
❑	Preparation protocoles			
❑	Leveling of topo			
❑	Filling up of sediment supply Qs			
❑	Empty outlet basket Qs			
❑	Basket for the samples Qs			
❑	Locking of the crane / Empty basket below belts			
❑	Install photos			
	Checking			
❑	Balance	C1		
❑	Pompes	C2		
❑	Limnimetres	z=200 C3	File:________.xls	
❑	UVP	C4		
❑	Solid discharge Qs	C5		________
	Test			
❑	Booting computer		________	
❑	Starting frame		________	
❑	Leveling of canal border		________	
	Test/ armoring			
❑	Starting of the pump		________	
❑		END	________	
❑	Starting Qs		________	________
❑ *	**Measurement during test (page 2)**		________	
❑ *	**Level meas. during night**		________	
	Pos=____ x=______	y=______	z=______	
❑	Stop supply Qs		________	
❑	Stop pump		________	
❑	Copy Files			
❑	Copy photos from digit. camera			
	Final measurement		times see log file	
❑ *	Water level			
	Starting of the pump		________	________
	END		________	________
	Start sediment supply Qs		________	________
	Mesasurement	Pos___	________	________
	Stop supply Qs		________	________
	Stop pump		________	________
❑ *	Velocity			
	Starting of the pump		________	________
	END		________	________
	Start sediment supply Qs		________	________
	Mesasurement	Pos___	________	________
	Stop supply Qs		________	________
	Stop pump		________	________
❑	Bed level		________	________
❑	Manual bed level (in/outlet)		________	
❑	Photos of topography		________	
❑	Photos of armoring (every 15°)		________	
❑	Armoring samples		________	
❑	Unlocking of the crane		________	
❑	Copy files (Lev, V, Log) PC2		________	
❑	Copy / develop photos (PC2)		________	

Alimentation			**Restitution**		
Heure hh:mm	*Bacs #*	*Masse [kg] kg*	*Heure hh:mm*	*M brut kg*	*Tare kg*
	filled				
resting:					
resting:					

Remarks, observations

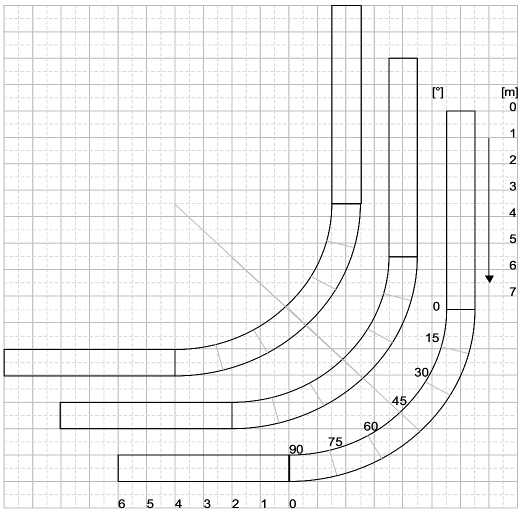


Figure 2.2: General protocol

Test protocole **Date** ________ **ID** ________ *

PAGE 2

Measurement [h]	[min]			Time [h:min]	Qs [g/min]	Number
—	10	Levelling canal border	P1			1
	20	Gravel sample	P2			
	30	Photo (page1)	P3			
	35	Verify Qe, Qs (Lev.)				
	35	Verify sediment supply / retain				
	40	Levelling canal border	P1			2
	50	Gravel sample	P2			
	60	Photo (page1)	P3			
	5	Verify Qe, Qs (Lev.)				
	5	Verify sediment supply / retain				
—	10	Levelling canal border	P1			3
	20	Gravel sample	P2			
	30	Photo (page1)	P3			
	35	Verify Qe, Qs (Lev.)				
	35	Verify sediment supply / retain				
	40	Levelling canal border	P1			4
	50	Gravel sample	P2			
	60	Photo (page1)	P3			
	5	Verify Qe, Qs (Lev.)				
	5	Verify sediment supply / retain				
—	10	Levelling canal border	P1			5
	20	Gravel sample	P2			
	30	Photo (page1)	P3			
	35	Verify Qe, Qs (Lev.)				
	35	Verify sediment supply / retain				
	40	Levelling canal border	P1			6
	50	Gravel sample	P2			
	60	Photo (page1)	P3			
	5	Verify Qe, Qs (Lev.)				
	5	Verify sediment supply / retain				
—	10	Levelling canal border	P1			7
	20	Gravel sample	P2			
	30	Photo (page1)	P3			
	35	Verify Qe, Qs (Lev.)				
	35	Verify sediment supply / retain				
	40	Levelling canal border	P1			8
	50	Gravel sample	P2			
	60	Photo (page1)	P3			
	5	Verify Qe, Qs (Lev.)				
	5	Verify sediment supply / retain				
—	10	Levelling canal border	P1			9
	20	Gravel sample	P2			
	30	Photo (page1)	P3			
	35	Verify Qe, Qs (Lev.)				
	35	Verify sediment supply / retain				
	40	Levelling canal border	P1			10
	50	Gravel sample	P2			
	60	Photo (page1)	P3			
	5	Verify Qe, Qs (Lev.)				
	5	Verify sediment supply / retain				

Measurement [h]	[min]			Time [h:min]	Qs [g/min]	Number
—	10	Levelling canal border	P1			11
	20	Gravel sample	P2			
	30	Photo (page1)	P3			
	35	Verify Qe, Qs (Lev.)				
	35	Verify sediment supply / retain				
	40	Levelling canal border	P1			12
	50	Gravel sample	P2			
	60	Photo (page1)	P3			
	5	Verify Qe, Qs (Lev.)				
	5	Verify sediment supply / retain				
—	10	Levelling canal border	P1			13
	20	Gravel sample	P2			
	30	Photo (page1)	P3			
	35	Verify Qe, Qs (Lev.)				
	35	Verify sediment supply / retain				
	40	Levelling canal border	P1			14
	50	Gravel sample	P2			
	60	Photo (page1)	P3			
	5	Verify Qe, Qs (Lev.)				
	5	Verify sediment supply / retain				
—	10	Levelling canal border	P1			15
	20	Gravel sample	P2			
	30	Photo (page1)	P3			
	35	Verify Qe, Qs (Lev.)				
	35	Verify sediment supply / retain				
	40	Levelling canal border	P1			16
	50	Gravel sample	P2			
	60	Photo (page1)	P3			
	5	Verify Qe, Qs (Lev.)				
	5	Verify sediment supply / retain				
—	10	Levelling canal border	P1			17
	20	Gravel sample	P2			
	30	Photo (page1)	P3			
	35	Verify Qe, Qs (Lev.)				
	35	Verify sediment supply / retain				
	40	Levelling canal border	P1			18
	50	Gravel sample	P2			
	60	Photo (page1)	P3			
	5	Verify Qe, Qs (Lev.)				
	5	Verify sediment supply / retain				
—	10	Levelling canal border	P1			19
	20	Gravel sample	P2			
	30	Photo (page1)	P3			
	35	Verify Qe, Qs (Lev.)				
	35	Verify sediment supply / retain				
	40	Levelling canal border	P1			20
	50	Gravel sample	P2			*
	60	Photo (page1)	P3			
	5	Verify Qe, Qs (Lev.)				
	5	Verify sediment supply / retain				

* ***Big sample used for sieving analysis (others only weighting)***

Protocoles samples.xls / Essai2 e 29.04.2002 / dh

Figure 2.3: General protocol - page 2

P1. Relevé sur la paroi extérieure **Date** ____________________ **ID** ________________________________

Relevé

- ☐ relevé 1 à 10 *mesuré depuis le fond en mm*
- ☐ relevé 11 à 20

Axe	Eau										Fond											
[m, °]	1	2	3	4	5	6	7	8	9		ini	pavage	1	2	3	4	5	6	7	8	9	
Entrée																						
1.65 m																						
1.95 m																						
2.25 m																						
2.55 m																						
2.85 m																						
3.15 m																						
3.45 m																						
3.75 m																						
4.05 m																						
4.35 m																						
4.65 m																						
4.95 m																						
5.25 m																						
5.55 m																						
5.85 m																						
6.15 m																						
6.45 m																						
6.75 m																						
7.05 m																						
7.35 m																						
Rayon																						
1.00°																						
3.75°																						
6.50°																						
8.50°																						
11.25°																						
14.00°																						
16.00°																						
18.75°																						
21.50°																						
23.50°																						
26.25°																						
29.00°																						
31.00°																						
33.75°																						
36.50°																						
38.50°																						
41.25°																						
44.00°																						
46.00°																						
48.75°																						
51.50°																						
53.50°																						
56.25°																						
59.00°																						
61.00°																						
63.75°																						
66.50°																						
68.50°																						
71.25°																						
74.00°																						
76.00°																						
78.75°																						
81.50°																						
83.50°																						
86.25°																						
89.00°																						
Sortie																						
0.15 m																						
0.45 m																						
0.75 m																						
1.05 m																						
1.35 m																						
1.65 m																						
1.95 m																						
2.25 m																						
2.55 m																						
2.85 m																						
3.15 m																						
3.45 m																						
3.75 m																						
4.05 m																						
4.35 m																						
4.65 m																						
4.95 m																						
5.25 m																						
5.55 m																						
5.85 m																						

Figure 2.4: Protocol for the manual (water and bed level) recordings on the outer side wall

P2. Echantillons de sédiments **Date** ______________________ **ID** ______________________

PAGE 1

Granulométrie		Echantillon 1			Echantillon 2			Echantillon 3			Echantillon 4			Echantillon 5		
		Brut	*Tare*	*Net*	*Brut*	*Tare*	*Net*	*Brut*	*Tare*	*Net*	*Brut*	*Tare*	*Net*	*Brut*	*Tare*	*Net*
N° de récipient	*Nr*															
Temps prise	*h:min*															
Tare halle	*g*															
Poids halle	*g*															
Temps	*min*															
Débit solide	*g/min*															
Poids brut avant	*g*															
31.5	*g*															
22.4	*g*															
16.0	*g*															
11.2	*g*															
8.0	*g*															
5.6	*g*															
4.0	*g*															
2.8	*g*															
2.0	*g*															
Reste	*g*															
Poids après																
Remarques																

Granulométrie		Echantillon 6			Echantillon 7			Echantillon 8			Echantillon 9			Echantillon 10		
		Brut	*Tare*	*Net*	*Brut*	*Tare*	*Net*	*Brut*	*Tare*	*Net*	*Brut*	*Tare*	*Net*	*Brut*	*Tare*	*Net*
N° de récipient	*Nr*															
Temps prise	*h:min*															
Tare halle	*g*															
Poids halle	*g*															
Temps	*min*															
Débit solide	*g/min*															
Poids avant	*g*															
31.5	*g*															
22.4	*g*															
16.0	*g*															
11.2	*g*															
8.0	*g*															
5.6	*g*															
4.0	*g*															
2.8	*g*															
2.0	*g*															
Reste	*g*															
Poids après																
Remarques																

Granulométrie		Echantillon 11			Echantillon 12			Echantillon 13			Echantillon 14			Echantillon 15		
		Brut	*Tare*	*Net*	*Brut*	*Tare*	*Net*	*Brut*	*Tare*	*Net*	*Brut*	*Tare*	*Net*	*Brut*	*Tare*	*Net*
N° de récipient	*Nr*															
Temps prise	*h:min*															
Tare halle	*g*															
Poids halle	*g*															
Temps	*min*															
Débit solide	*g/min*															
Poids brut avant	*g*															
31.5	*g*															
22.4	*g*															
16.0	*g*															
11.2	*g*															
8.0	*g*															
5.6	*g*															
4.0	*g*															
2.8	*g*															
2.0	*g*															
Reste	*g*															
Poids brut après																
Remarques																

Figure 2.5: Protocols for the sieving / grain size distribution

P2^LT. Echantillons de sédiments **Date** ______________ **ID** ______________

Granulométrie		Sample 1	Sample 2	Sample 3	Sample 4	Sample 5
Basket Nr	*Nr*					
Time	*h:min*					
Empty	*g*					
Total Weight	*g*					
Sediment weight	*min*					
Duration	*min*					
Remarks						

Granulométrie		Sample 6	Sample 7	Sample 8	Sample 9	Sample 10
Basket Nr	*Nr*					
Time	*h:min*					
Empty	*g*					
Total Weight	*g*					
Sediment weight	*min*					
Duration	*min*					
Remarks						

Granulométrie		Sample 11	Sample 12	Sample 13	Sample 14	Sample 15
Basket Nr	*Nr*					
Time	*h:min*					
Empty	*g*					
Total Weight	*g*					
Sediment weight	*min*					
Duration	*min*					
Remarks						

Granulométrie		Sample 16	Sample 17	Sample 18	Sample 19	Sample 20
Basket Nr	*Nr*					
Time	*h:min*					
Empty	*g*					
Total Weight	*g*					
Sediment weight	*min*					
Duration	*min*					
Remarks		*upstream*	*upstream*	*downstream*	*downstream*	
		outside	*inside*	*outside*	*inside*	

Granulométrie		Sample 22	Sample 22	Sample 23	Sample 24	Sample 25
Basket Nr	*Nr*					
Time	*h:min*					
Empty	*g*					
Total Weight	*g*					
Sediment weight	*min*					
Duration	*min*					
Remarks						

Granulométrie		Sample 26	Sample 27	Sample 28	Sample 29	Sample 30
Basket Nr	*Nr*					
Time	*h:min*					
Empty	*g*					
Total Weight	*g*					
Sediment weight	*min*					
Duration	*min*					
Remarks						

Figure 2.6: Protocol for sediment sampling at the outlet

P2b. Echantillons pesage **Date:** ____________ **ID** ____________

Balance ❑ LCH ❑ LRH

Remarques ____________

Température de l'eau	θ_e	17.5 °C	Il faut soit	- vide plus séd sec
Densité de l'eau	ρ_e	0.999 t/m3		- eau plus eau+séd
Densité des sédiments	ρ_s	2.635 t/m3		

Mesure	vide	+eau	+eau+séd	+séd sec	Masse séd mes. à séc	mes. hum.
	g	g	g	g	g	g
Echantillon 1						
Echantillon 2						
Echantillon 3						
Echantillon 4						
Echantillon 5						
Echantillon 6						
Echantillon 7						
Echantillon 8						
Echantillon 9						
Echantillon 10						
Echantillon 11						
Echantillon 12						
Echantillon 13						
Echantillon 14						
Echantillon 15						
Echantillon 16						
Echantillon 17						
Echantillon 18						
Echantillon 19						
Echantillon 20						
Echantillon 21						
Echantillon 22						
Echantillon 23						
Echantillon 24						
Echantillon 25						
Echantillon 26						
Echantillon 27						
Echantillon 28						
Echantillon 29						
Echantillon 30						
SOMME						
MOYENNE	#DIV/0!	#DIV/0!	#DIV/0!	#DIV/0!		

Mesure cumulée

+eau	valeur préc.	Cumul

Figure 2.7: Protocol to record weighting results of the sediment samples taken at the outlet

P3. Photos Date ________________ ID ________________

Préparer 2 Protocoles (numérique et digital)

Caméra

- ❑ normale Canon / Minolta / Canon / Minolta / Nikon
- ❑ digitale

Légende

- Position et direction de prise du photographe (1-4)
- Eclairage (A-D)

Photos

	Position photographe															Prise vers				Eclairage allumé						***pendant l'essai***, *prendre position 1 avec caméra numérique* ***à la fin*** *positions 1-4 avec caméra normale, + particularités + granulo à 45°, 90° et érosion max. (vertical, centre du canal)*	
								longitudinal				latéral															
N°	Position 1a	Position 1b	Position 1c	Position 2	Position 3	Position 4	Position 5	tronç. amont	en courbe	tronç. aval	Position [m/°]	Paroi int.	Paroi ext.	Dans canal	Distance	l'amont	l'aval	l'intérieur	l'extérieur	Position A	Position B	Derrière cam.	Flash	Halle-Néons	Halle-Spots	Caméra digitale	Remarques
1																											
2																											
3																											
4																											
5																											
6																											
7																											
8																											
9																											
10																											
11																											
12																											
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55																											
56																											
57																											
58																											
59																											
60																											
	Position							longitudinal				latéral				Direction				Lumière						Remarques	
	1a	1b	1c	2	3	4	5	Amont	Courbe	Aval	Pos [m/°]	Int	Ext	Canal	Dist. [m]	Amont	Aval	Int	Ext	A	B	Derrière	Flash	Halle-Né	Halle-Sp	***Positions 1a-c: grands spots de la halle + néons allumés*** ***Autres positions: spot derrière l'observateur (env. 40 cm sur sol)***	

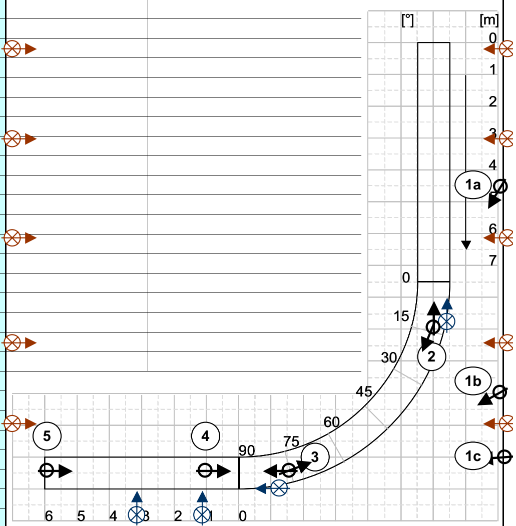


Figure 2.8: Protocol of taken pictures

The scheme of the platform gives the positions from which the systematic pictures were taken.

PA. Relevé de la topo / vitesse **Date** ______________ **ID** ____________________________

Relevé

- ❑ Topo *Profondeur en mm (lecture limni) depuis le bord du canal*
- ❑ Vitesse *en mm/s*

Axe [m, °]	Distance au bord intérieur du canal [cm]															
		10	20	30	40	50	60	70	80	90	100					
Entrée																
1.0 m																
1.5 m																
2.0 m																
2.5 m																
3.0 m																
3.5 m																
4.0 m																
4.5 m																
5.0 m																
5.5 m																
6.0 m																
6.5 m																
7.0 m																
7.5 m																
Rayon																
4°																
8°																
12°																
16°																
20°																
24°																
28°																
32°																
36°																
40°																
44°																
48°																
52°																
56°																
60°																
64°																
68°																
72°																
76°																
80°																
84°																
88°																
90°																
Sortie																
0.5 m																
1.0 m																
1.5 m																
2.0 m																
2.5 m																
3.0 m																
3.5 m																
4.0 m																
4.5 m																
5.0 m																
5.5 m																
6.0 m																
		10	20	30	40	50	60	70	80	90	100					

Figure 2.9: Protocol to manually record the bed topography at the inlet and outlet reach

2.4 Summary of particular events and phenomena during the tests

2.4.1 Events during the tests - sorted by category

During the performed tests, an important number of irregularities occurred related to the different elements of the quite complete experimental setup. All the possible precautions have been taken to limit an impact on the results. Nevertheless it cannot be excluded that some of the events could have an influence on the final results. For this reasons the following few lines give an overview of the main problems during the tests. All indicated times (in brackets) are counted from the beginning of the test.

a) *Infrastructure - the sediment feeder*

- C3d (1h) the sediment feeder was blocked by a plastic sheet. The sediment feeder was emptied by introducing the sediments "manually" into the channel (by opening the gate 7 on Fig. 4.6 and 4.7).

b) *Infrastructure - the tilting gate at the outlet*

During the tests, the tilting gate at the outlet, lowered during the tests, started floating. This happened during the following tests:

- B3d (2h) tilting gate came up.
- B4d (1h and 3h) tilting gate came up.
- C2d (towards end of velocity measurements at frame pos. 8) tilting gate came up.
- C4d (0.5h, before first sediment sample at outlet was taken) tilting gate came up.
- D4d (6.5h) tilting gate came up.

c) *Infrastructure - the sediment sampling device at the outlet*

The sediment sampling device at the outlet lead to some problems. The L-shaped filter was lowered and lifted by a crank lever. During the sampling, several times individual stones were squeezed in between the lateral walls of the channel and the mobile L (despite a special element closing the gap between the side wall and the L). This crank lever broke several times.

- C3d (4h) the sediment sampling device was not completely lowered (it needed to be pushed down). Therefore the taken sediment samples could be too small.
- D3c (2h) the crank lever broke. It was repaired during the tests.
- D3d (2h) the sediment sampling device was blocked by a stone. One sample was left out and the tests were continued without interruption.
- D4c (2h) the fine grid of the sediment sampling device was replaced during the tests (without interruption of the tests, but some samples are missing).
- D4c (4.5h) the crank lever broke and was not repaired anymore.

d) Infrastructure - the pumps

Several times the used pump was accidentally cut. This had the undesired effect that the channel was emptied without lifted tilting gate. Observations and comparisons between the bed before and after an accidental cut of the pump showed that almost no erosion occurred (maybe locally one or two stones moved, but without influence on the bed topography):

- B2c (3h) the automatic regulation cut pump 7 due to pressure fluctuations.
- C2b (at test start) pump 7 cut six times. The tests were continued with pump 6 over a bypass pipe. The discharge indicator was exchanged, which solved the problem for the next tests.
- C3c (9h) the pump cut twice at a 5 minutes interval.
- C4c (2h) the pump cut.
- C4d (12h) somebody switched off the pump.
- D4d (during startup) somebody cut the pump.

e) Measurements - the frame

Another type of problem was related to the measurements. The frame had to be positioned manually at eight different locations where it was fixed as indicated on Fig. 4.17. A few times this fixation was badly fixed and the frame slightly moved.

- B3d and C1b the frame moved a few centimeters and the measurements were repeated.
- C2d (11h) the measurement frame hit the inner side wall. The frame geometry needed to be readjusted. After a check of the geometry as well of the different probes, the tests were resumed.
- C4c velocity measurements at positions 7 and 8 were recorded at a z-level of -5 mm.
- D2d (end of the test) the probe support dropped down. A check of the geometry and the probes showed that there was no damage.
- D3d water level measurements at position 8: the frame was not fixed, but it did not move.

f) Measurements - informatics

- B3a (7h) Excel (recording of the water levels and discharges) crashed.
- B3b (7h) network connection to UVP computer lost. The test was interrupted to reestablish the connection for the velocity measurements.
- B3d (6.5, 7 and 7.5h) Excel crashed. The number of cells considered for averaging the levels was reduced. 2 hours later, Excel crashed again (o great!)
- B4c (5h) the second half of the test recordings (not the final measurement) failed due to an informatics error during saving the level file.
- B4d due to an Excel problem, the water level recordings are incomplete at frame position 9.
- C4c (2.3h) the power supply of the whole measurement equipment was cut accidentally. After a general startup procedure, the test was resumed.
- D4c (4h) the hard disk of the level acquisition device crashed. Due to a frequent backup, only the automatic level and discharge recordings of the first 4 hours were lost. After replacement of the computer, reinstallation of the data acquisition cards and programs, the

calibration of the ultrasonic gauges was checked. The tests were resumed about 10 days later.
- D4c (11h) the network connection to the UVP device could not be found. A reboot of the machine solved the problem.

g) Others

Other important modifications are given hereafter:
- All tests at high transport rates had to be interrupted periodically to replace the filtering basket at the outlet by an empty one. This was without influence on the scour process since the tilting gate was lifted to avoid any modification of the bed topography.
- B4b (1h) the last 3 vertical ribs at the outlet were introduced.
- C1a before test started the water of the general laboratory circuit was replaced. The temperature (end of september) went from about 20° to 10°.
- C1a before the test started a 3mm thick plastic plate fixed on the inner side wall was removed over the first 1 to 1.5 m at the inlet reach, because the conveyor belt had dropped sediments behind the plate. This was the only way to remove them. The influence on the further tests is not significant (there are still more than 6 m to the beginning of the bend).
- C3 all tests: some ribs did not stick well to the wall during the tests. The gap between the ribs and the wall opened up to a maximum of 10 mm (in general much less). The following ribs sticked well to the side wall: 6°, 8°, 22°, 30°, 50°, 52°, 58°, 60°, 82° and all ribs in the outlet.
- C3d (6h) just after a short break, the top 10 cm of the sill between the inlet reach and the inlet tank lifted up. The test was cut for 10 minutes to fix the problem.
- D3b the ultrasonic level gauge number 2 (at the inlet) had the fixation detached (fixed).

2.4.2 Events during the tests - sorted by test

All tests
- At high transport rates had to be interrupted periodically to replace the filtering basket at the outlet by an empty one. This was without influence on the scour process since the tilting gate was lifted to avoid any modification of the bed topography.

B1
- B1b (10h). Electric shortcut on the measurement frame (axis x). Repaired

B2
- B2**c** (3h) the automatic regulation cut pump 7 due to pressure fluctuations.

B3
- B3**a** (7h) Excel (recording of the water levels and discharges) crashed.
- B3**b** (7h) network connection to UVP computer lost. The test was interrupted to reestablish the connection for the velocity measurements.
- B3**d** (2h) tilting gate came up.
- B3d the frame moved a few centimeters and the measurements were repeated.

- B3d (6.5, 7 and 7.5h) Excel crashed. The number of cells considered for averaging the levels was reduced. 2 hours later, Excel crashed again (o great!)

B4

- B4**b** (1h) the last 3 vertical ribs at the outlet were introduced.
- B4**c** (5h) the second half of the test recordings (not the final measurement) failed due to an informatics error during saving the level file.
- B4**d** (1h and 3h) tilting gate came up.
- B4d due to an Excel problem, the water level recordings are incomplete at frame position 9.

C1

- C1**a** before test started the water of the general laboratory circuit was replaced. The temperature (end of september) went from about 20° to 10°.
- C1a before the test started a 3mm thick plastic plate fixed on the inner side wall was removed over the first 1 to 1.5 m at the inlet reach, because the conveyor belt had dropped sediments behind the plate. This was the only way to remove them. The influence on the further tests is not significant (there are still more than 6 m to the beginning of the bend).
- C1**b** the frame moved a few centimeters and the measurements were repeated.

C2

- C2**b** (at test start) pump 7 cut six times. The tests were continued with pump 6 (bypass). The discharge indicator was exchanged, which solved the problem for the following tests.
- C2**d** (11h) the measurement frame hit the inner side wall. The frame geometry needed to be readjusted. After a check of the geometry as well of the different probes, the tests were resumed.
- C2d (towards end of velocity measurements at frame pos. 8) tilting gate came up.

C3

- **C3** all tests: some ribs did not stick well to the wall during the tests. The gap between the ribs and the wall opened up to a maximum of 10 mm (in general much less). The following ribs sticked well to the side wall: 6°, 8°, 22°, 30°, 50°, 52°, 58°, 60°, 82° and all ribs in the outlet.
- C3**c** (9h) the pump cut twice at a 5 minutes interval.
- C3**d** (1h) the sediment feeder was blocked by a plastic sheet. The sediment feeder was emptied by introducing the sediments “manually” into the channel (by opening the gate 7 on Fig. 4.6 and 4.7).
- C3d (4h) the sediment sampling device was not completely lowered (it needed to be pushed down). Therefore the taken sediment samples could be too small.
- C3d (6h) just after a short break, the top 10 cm of the sill between the inlet reach and the inlet tank lifted up. The test was cut for 10 minutes to fix the problem.

C4

- C4**c** (2h) the pump cut.
- C4c (2.3h) the power supply of the whole measurement equipment was cut accidentally. After a general startup procedure, the test was resumed.
- C4c velocity measurements at positions 7 and 8 were recorded at a z-level of -5 mm.
- C4**d** (0.5h, before first sediment sample at outlet was taken) tilting gate came up.

- C4d (12h) somebody switched off the pump.

D2

- D2**d** (end of the test) the probe support dropped down. A check of the geometry and the probes showed that there was no damage.

D3

- D3**b** the ultrasonic level gauge number 2 (at the inlet) had the fixation detached (fixed).
- D3**c** (2h) the crank lever broke. It was repaired during the tests.
- D3**d** (2h) the sediment sampling device was blocked by a stone. One sample was left out and the tests were continued without interruption.
- D3d water level measurements at position 8: the frame was not fixed, but it did not move.

D4

- D4**c** (2h) the fine grid of the sediment sampling device was replaced during the tests (without interruption of the tests, but some samples are missing).
- D4c (4h) the hard disk of the level acquisition device crashed. Due to a frequent backup, only the automatic level and discharge recordings of the first 4 hours were lost. After replacement of the computer, reinstallation of the data acquisition cards and programs, the calibration of the ultrasonic gauges was checked. The tests were resumed about 10 days later.
- D4c (4.5h) the crank lever broke and was not repaired anymore.
- D4c (11h) the network connection to the UVP device could not be found. A reboot of the machine solved the problem.
- D4**d** (during startup) somebody cut the pump.
- D4d (6.5h) tilting gate came up.

2.4.3 Observations

- B4b erosion started at the downstream end of the bend at 15 to 20 cm from the outer wall.
- B4b coarse sediments accumulated at the inlet reach due to insufficient transport capacity.
- B4b (5h) the first scour was about 10 cm deeper at 15 cm from the outer wall compared to the value recorded on the side wall.
- B4c bed changes are smoother with a mr-spacing at 1° (compared to 2° and 4°).
- B4c recirculating current observed behind the bank at 60°.
- C1d white water on the first wave in the outlet reach (see pictures 21, 22, 28 and 29).
- C1d (4.5h) there seem to be temporarily 3 scour holes.
- C3b the sediment transport rate at the outlet is very regular.
- C4a some erosion (not very important) occurred in the outlet reach.
- D1c during the tests, the 2nd scour was temporarily about 10 to 15 cm deeper than the final scour. This could be due to a higher bed slope.
- D2b the sediment transport rate (feeding) was probably too high since an accumulation of the sediments in the inlet reach was observed.

APPENDIX 3

PRELIMINARY TESTS

3.1 Bed topography above reference level

The bed levels are given before the tests, after 120, 130, 140, 170 and 212.5 l/s (top to bottom)

TEST WITHOUT MACRO-ROUGHNESS

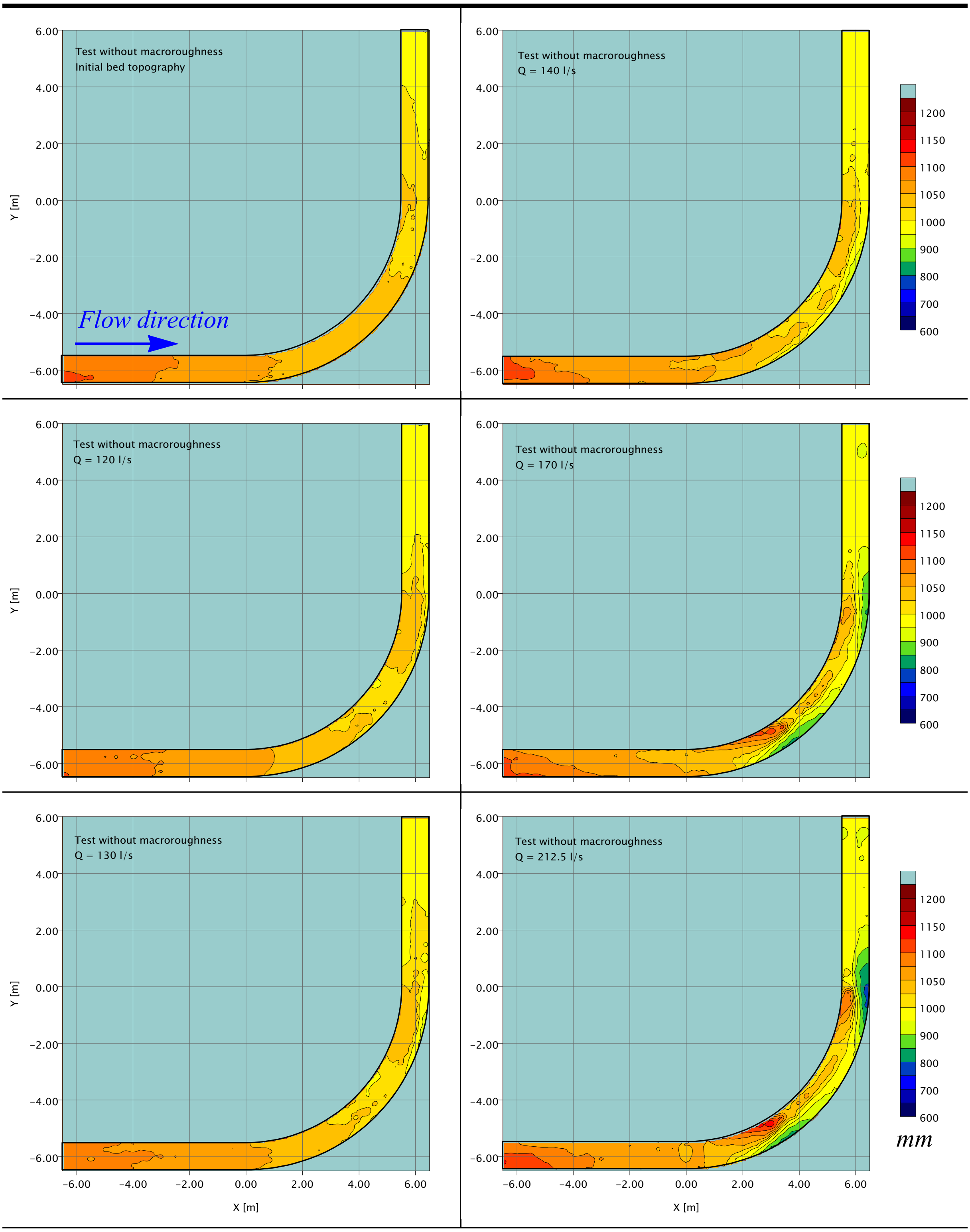


Table 3.1: Bed topography above reference level - preliminary test without mr, $J_f = 0.5\%$

3.2 *Bed topography compared to initial bed*

The last two plots compare the bed topography with and without mr (scour red. = values > 0).

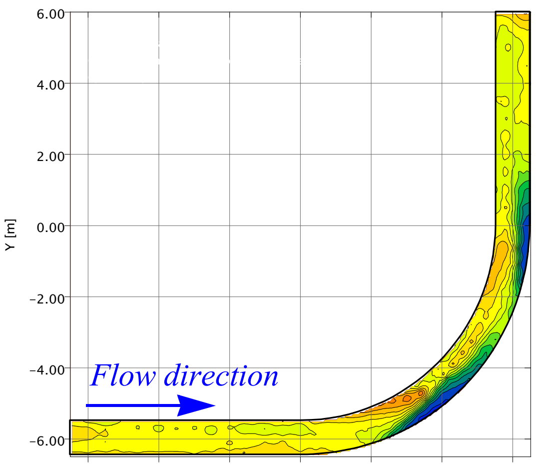
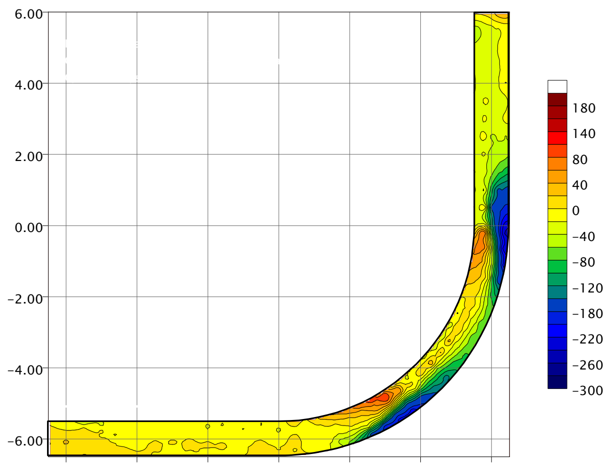
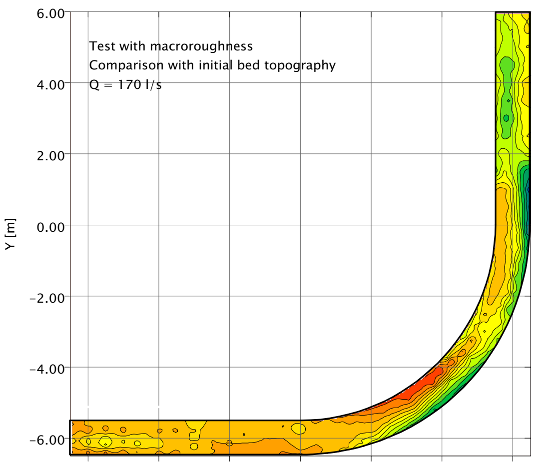
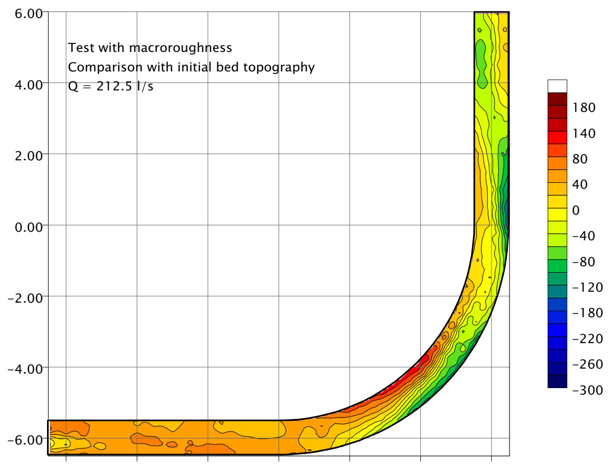
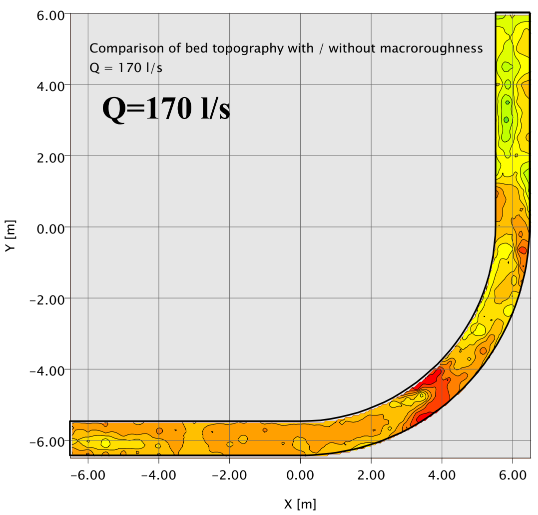
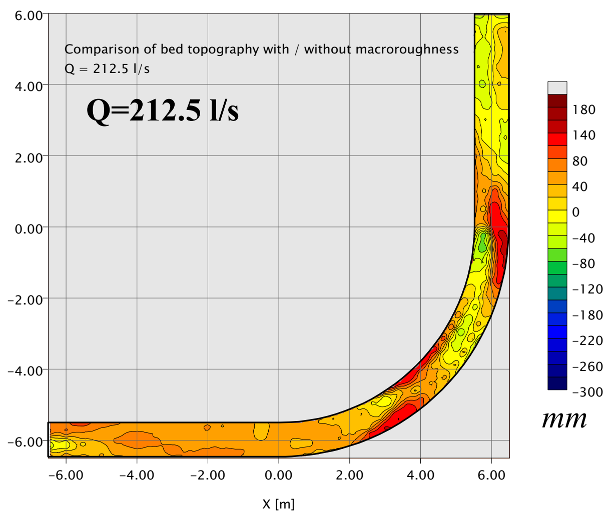
Q	170 l/s	212.5 l/s
WITHOUT MR		
MR SPACED EVERY 2°		
Comparison		

Table 3.2: Comparison of final topography with initial bed; comparison with/without mr

3.3 Longitudinal profile of the channel bed

3.3.1 Without macro-roughness

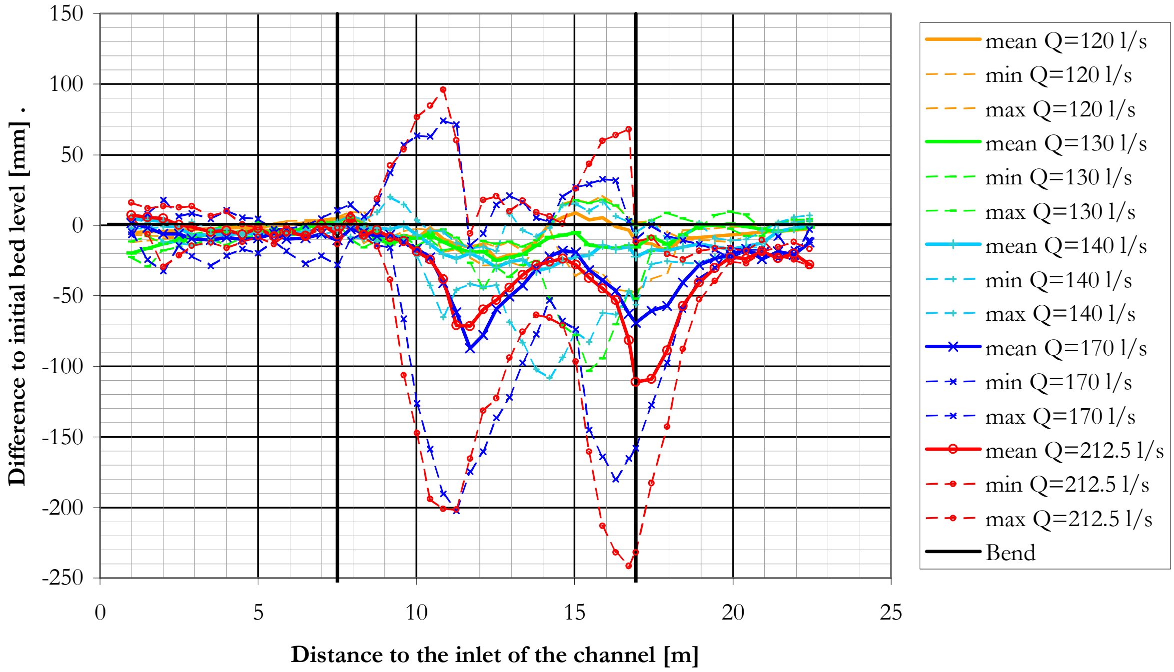


Figure 3.1: Evolution of the channel bed (average, min. and max. bed levels compared to initial bed) without macro-roughness (Test A01)

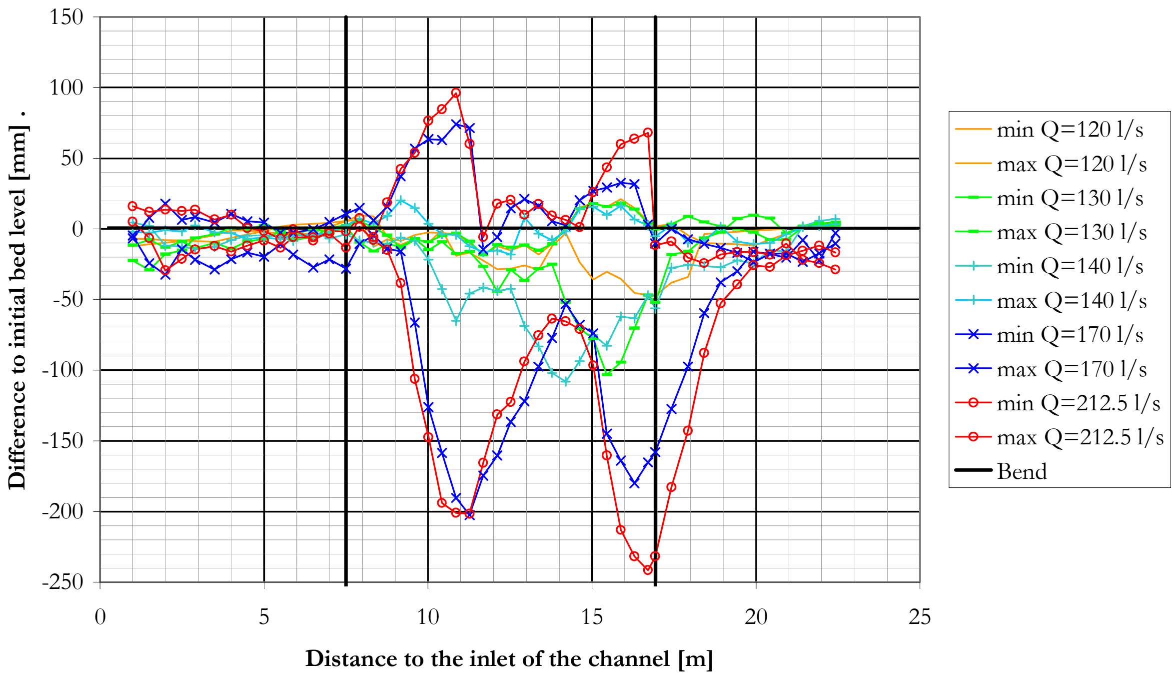


Figure 3.2: Evolution of the max. scour (min. level) and max. depositions (compared to initial bed) without macro-roughness (Test A01)

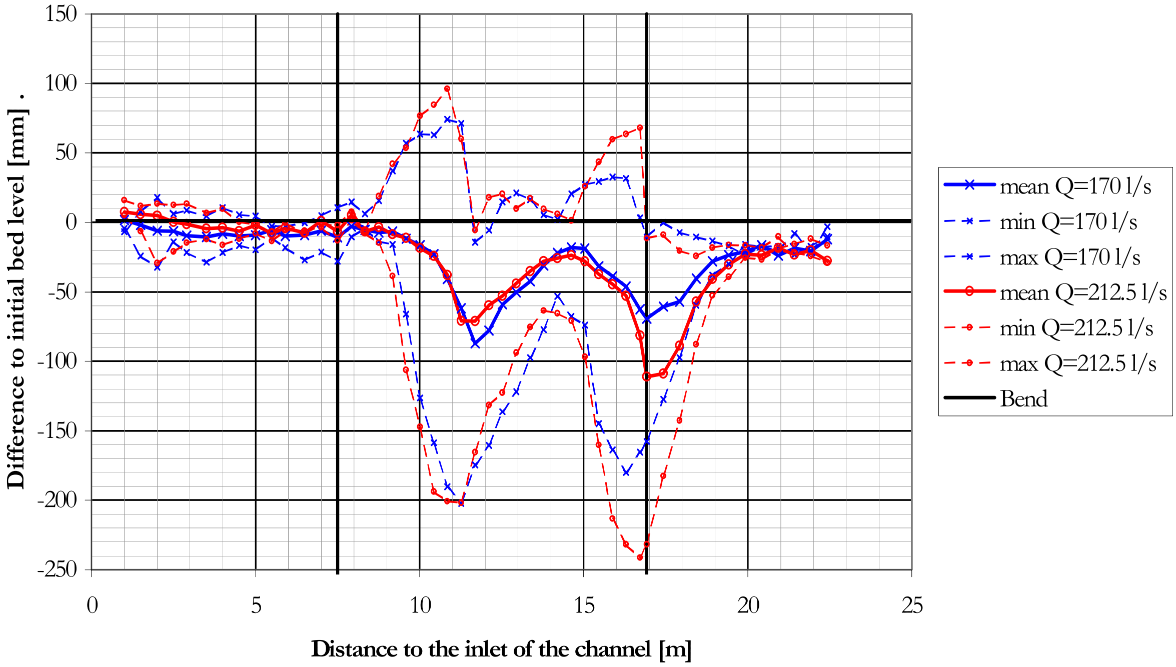


Figure 3.3: Evolution of the channel bed (compared to initial bed) for Q=170 and 212.5 l/s without macro-roughness (A01)

3.3.2 With macro-roughness (spaced every 2°)

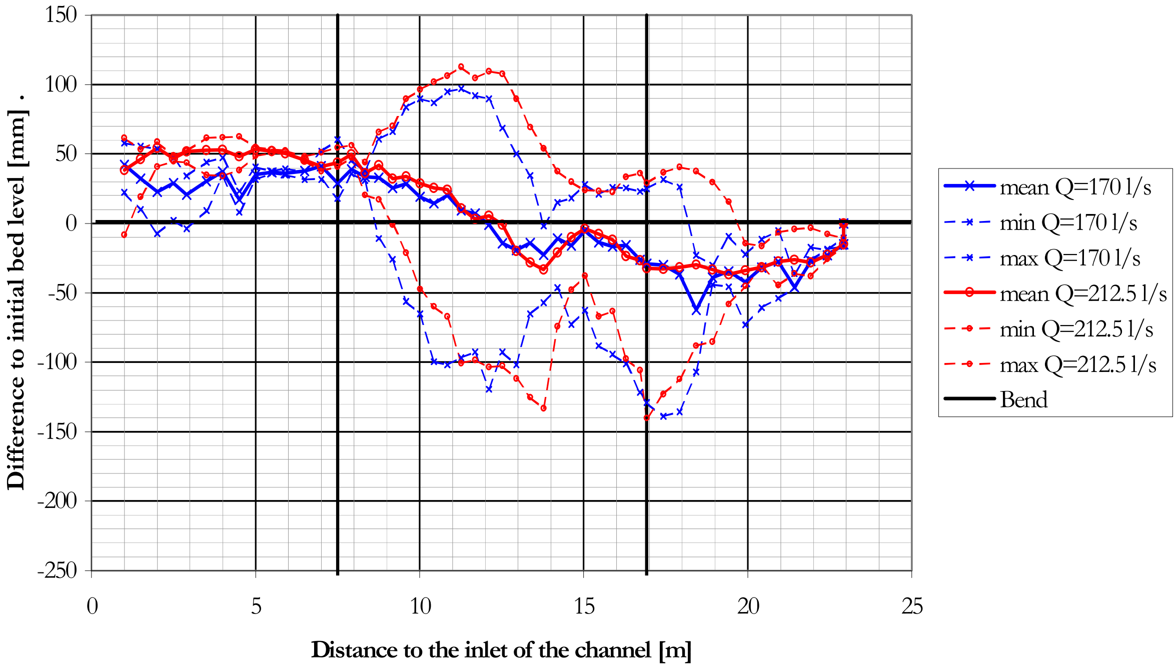


Figure 3.4: Evolution of the channel bed (compared to initial bed) for Q=170 and 212.5 l/s with macro-roughness every 2° (A02)

3.3.3 Comparison

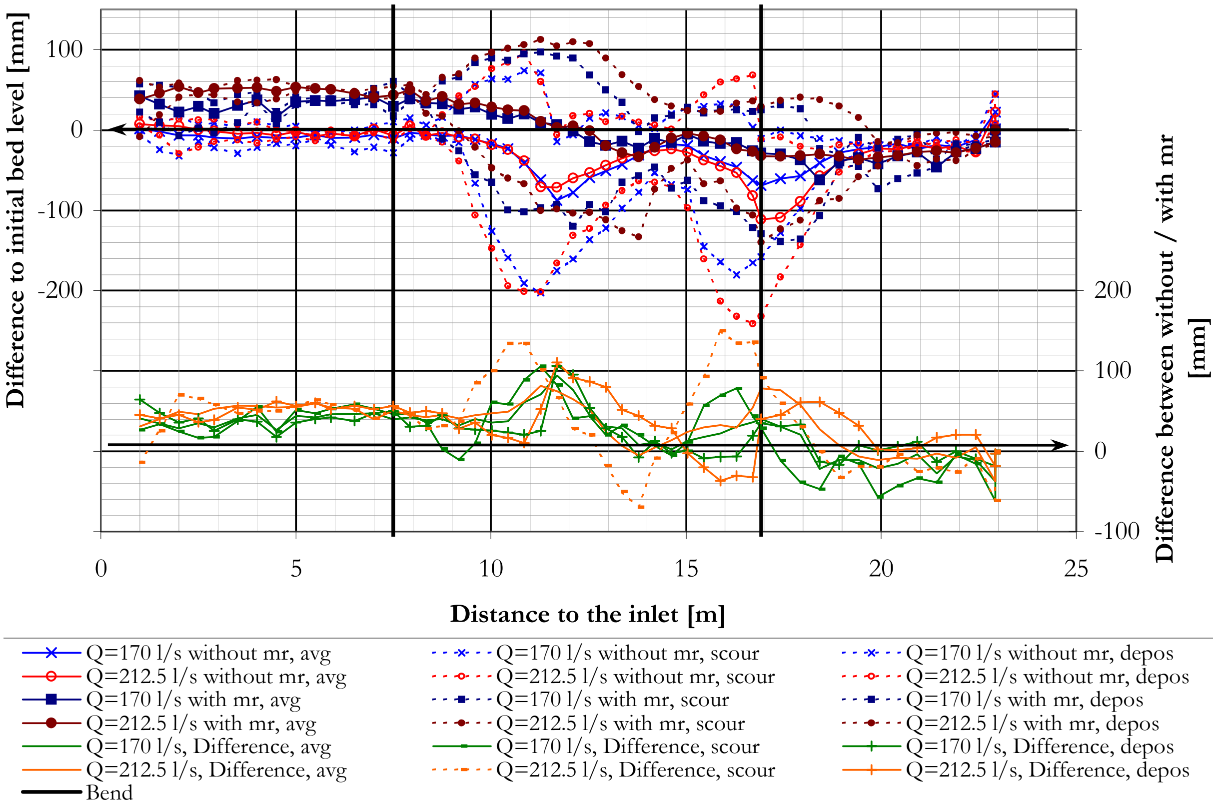


Figure 3.5: Comparison of the evolution of the channel bed
Difference with / without macro-roughness for Q=170 and 212.5 l/s

The lower parts of Fig. 3.5, 3.6 and 3.7 give the difference between the bed topography without ribs and the one with macro-roughness spaced every 2°. Figure 3.5 gives the two highest discharges on the same plot to allow a comparison of the influence of the discharge. The following figures present one discharge at the time.

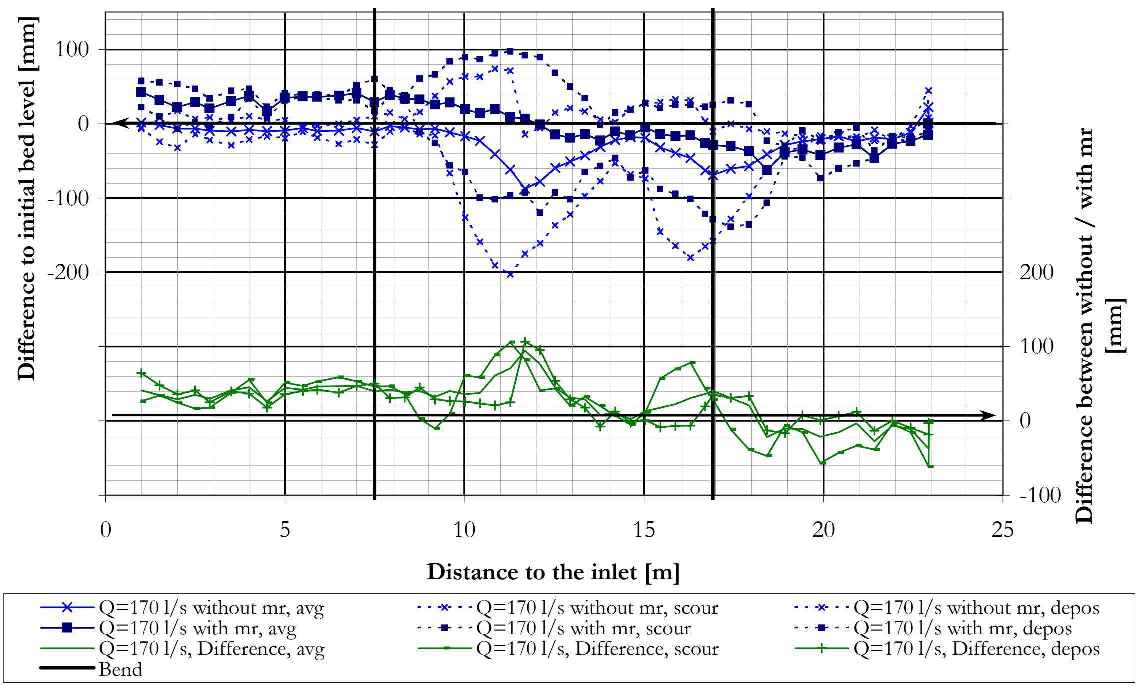


Figure 3.6: Comparison of the evolution of the channel bed
Difference with / without macro-roughness for Q=170 l/s

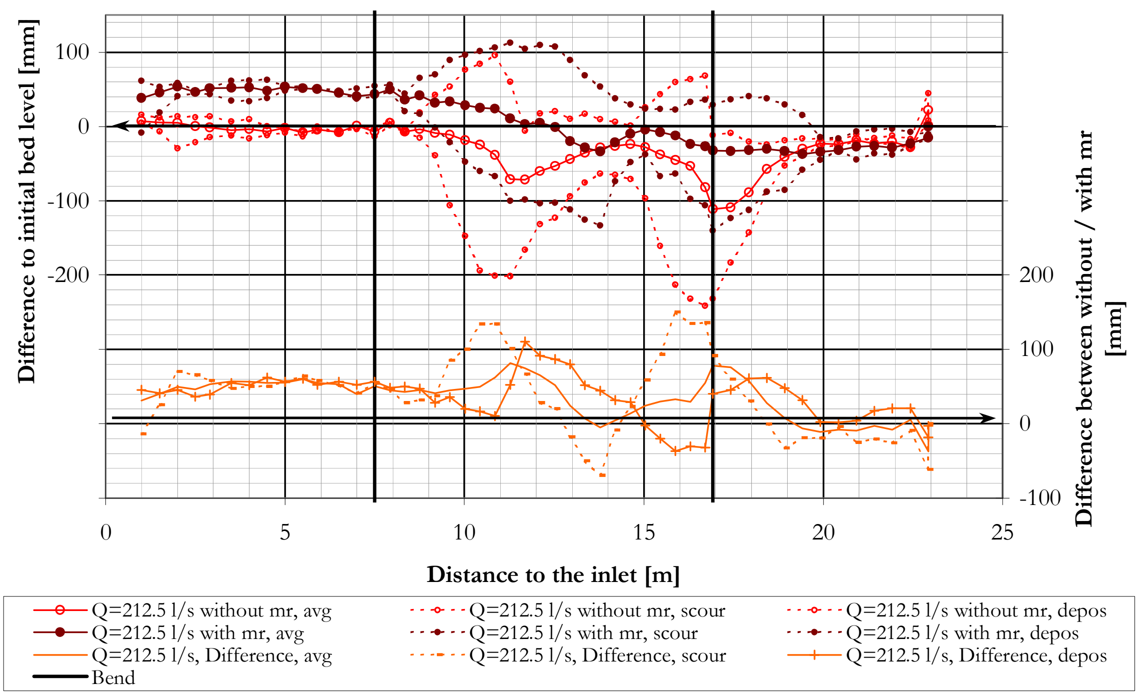
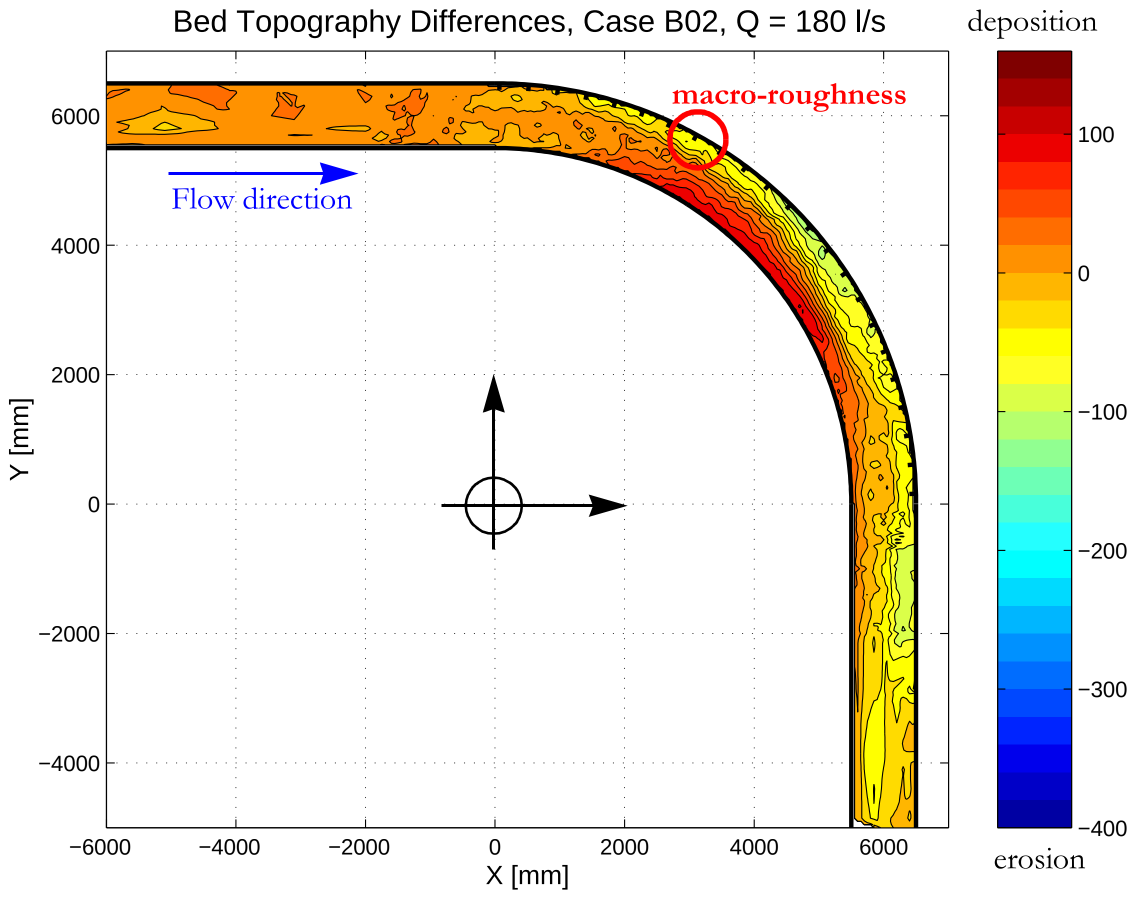


Figure 3.7: Comparison of the evolution of the channel bed
Difference with / without macro-roughness for Q=212.5 l/s

APPENDIX 4

BED TOPOGRAPHY COMPARED TO INITIAL BED LEVEL

This Appendix gives the measured final bed topography compared to the initial bed topography (recorded after the armoring at a discharge of 70 l/s).



Additional information can be found in the report in Chapter 5.3.1 and 6.2.1.

4.1 Channel slope S_0 = 0.35% - mr depth = 20 mm

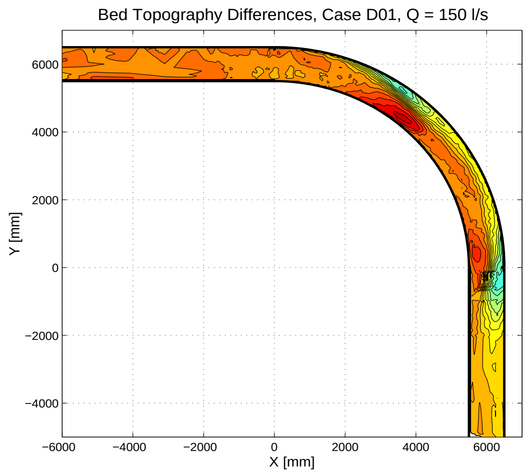
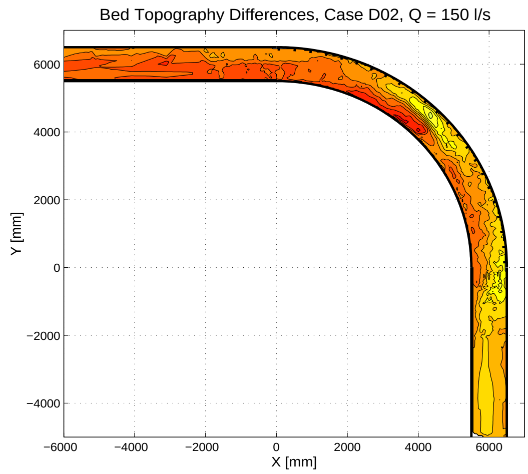
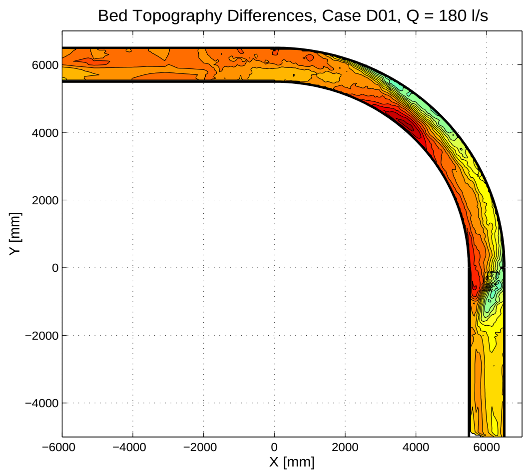
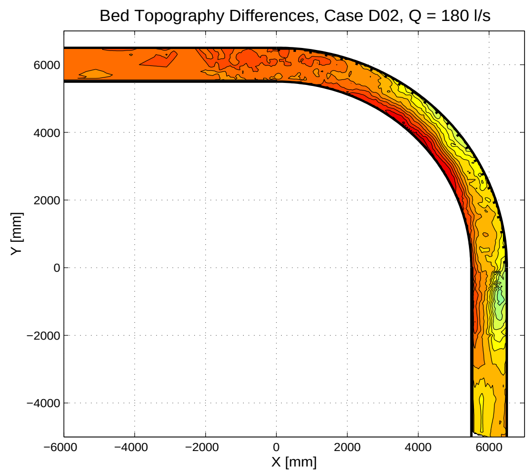
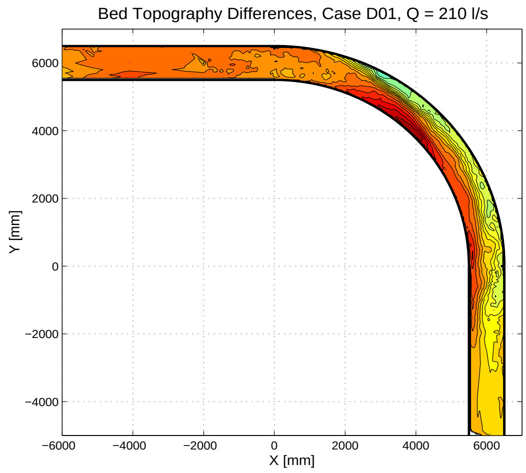
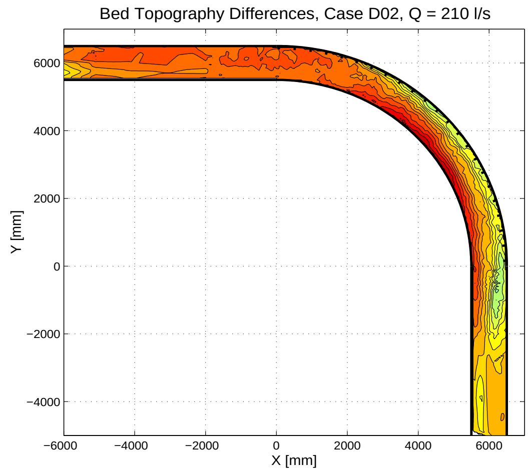
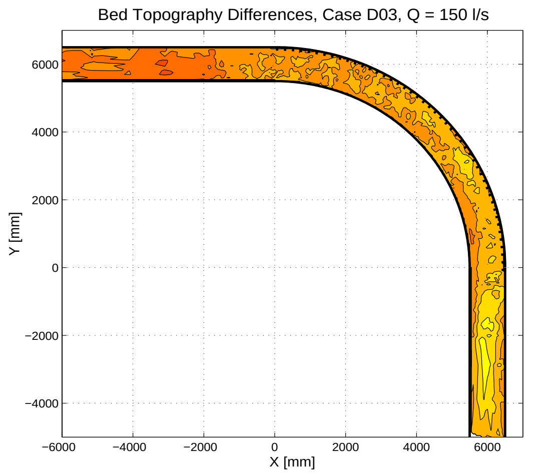
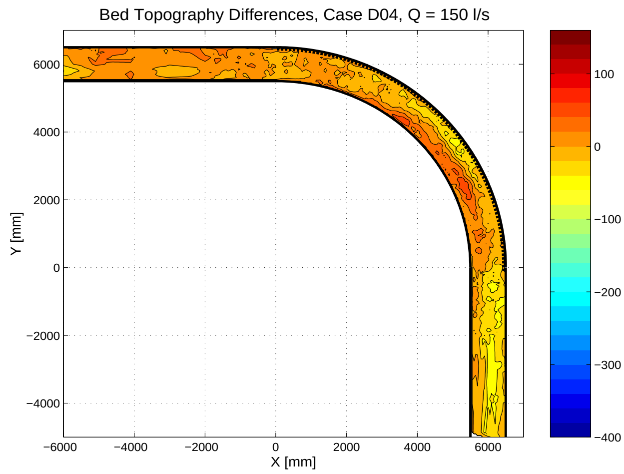
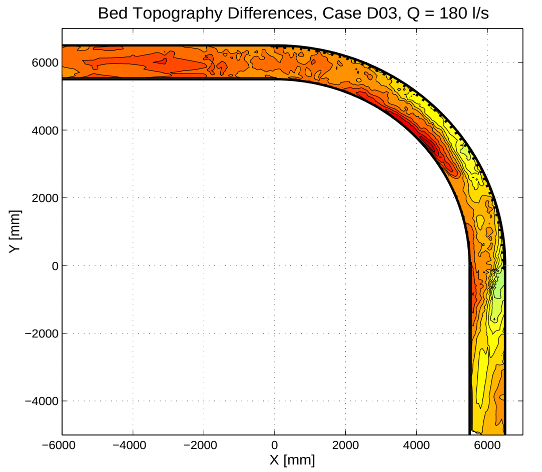
Q [L/S]	WITHOUT MR	WITH MR SPACING 4°
150		
180		
210		

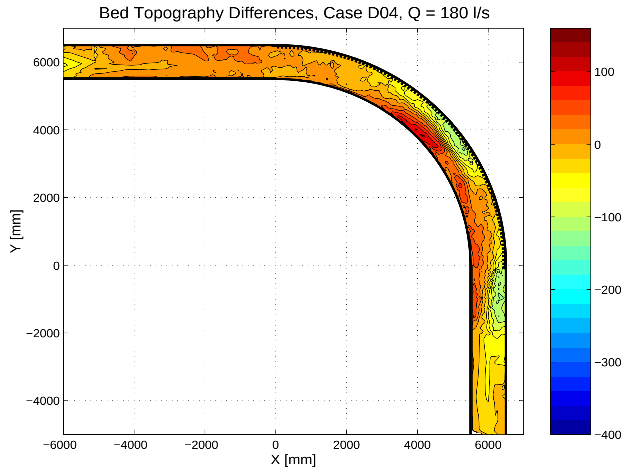
Table 4.1: Bed topography compared to initial bed level - S_0 = 0.35%

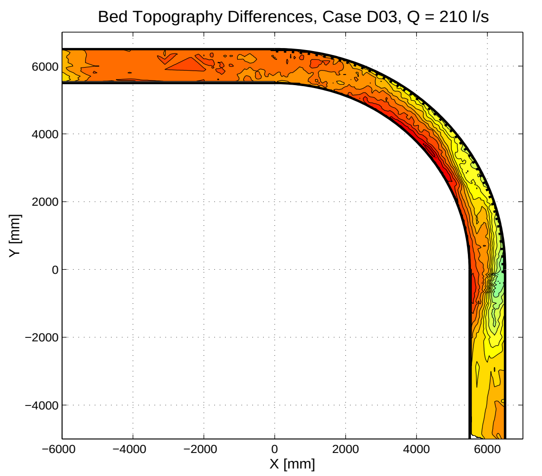
WITH MR SPACING 2°	WITH MR SPACING 1°

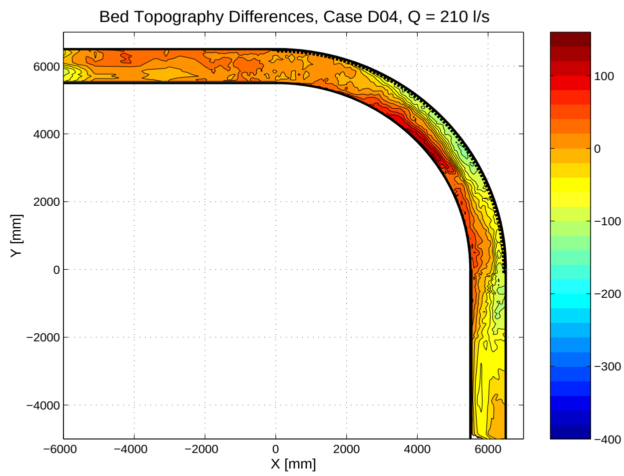












Distances in mm; Equidistance: 20 mm; Linear interpolation

4.2 *Channel slope S_0 = 0.50% - mr depth = 20 mm*

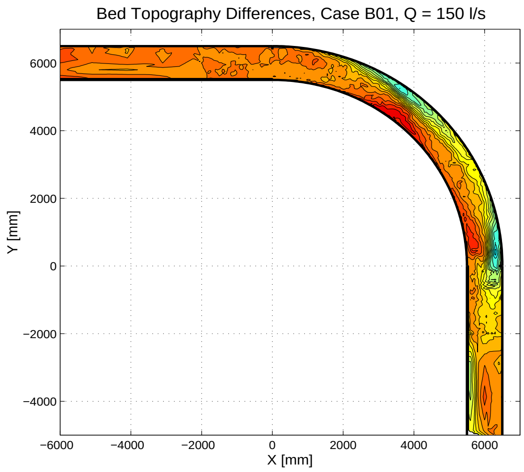
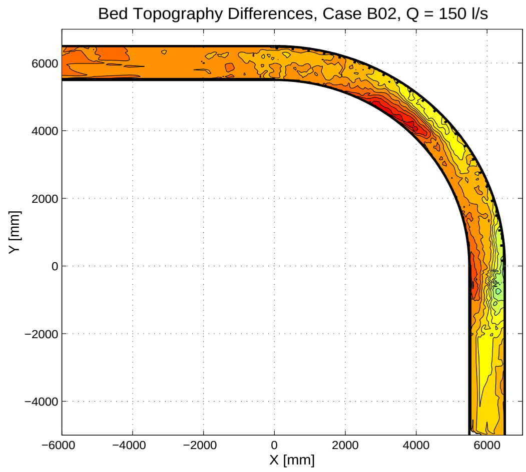
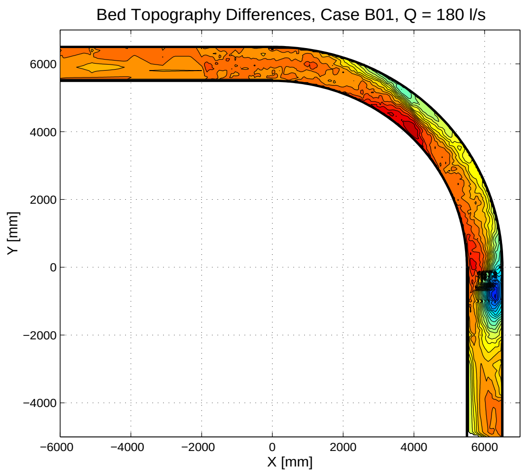
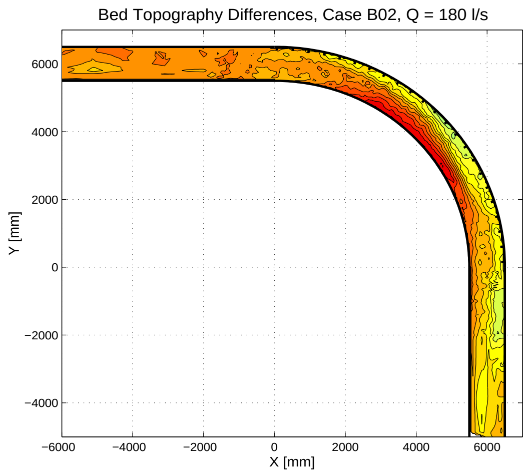
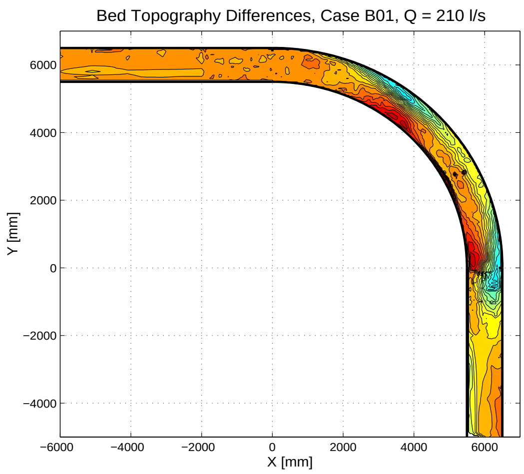
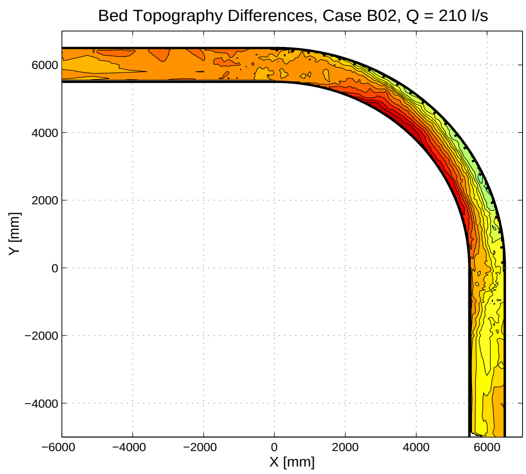
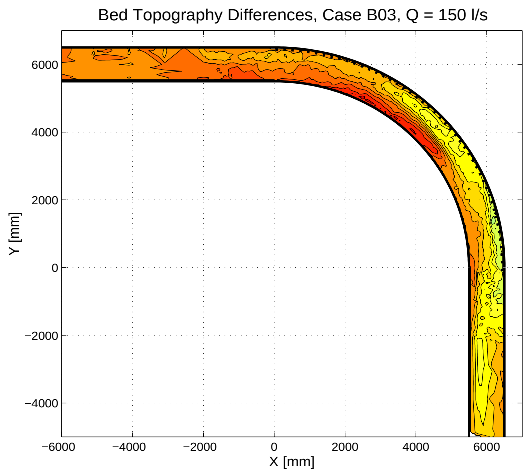
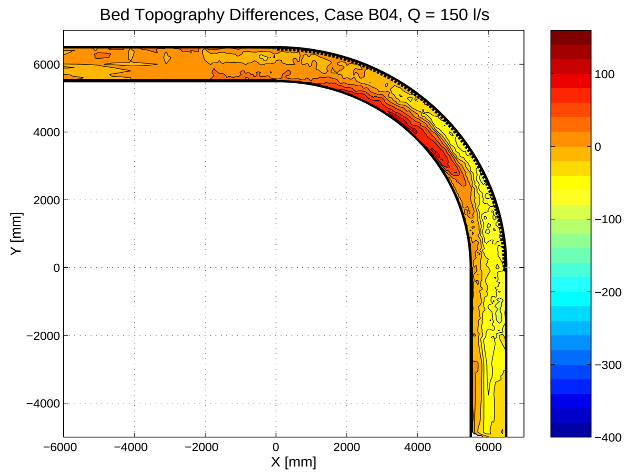
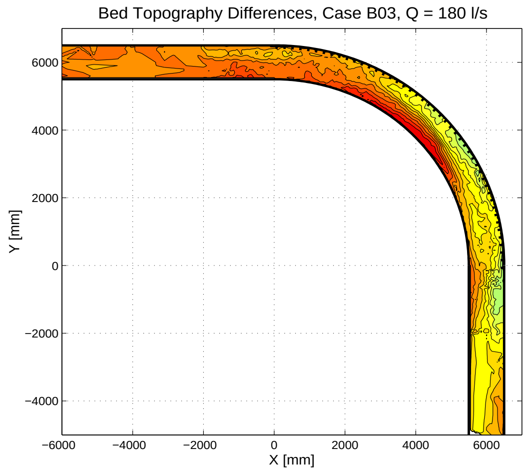
Q [L/S]	WITHOUT MR	WITH MR SPACING 4°
150		
180		
210		

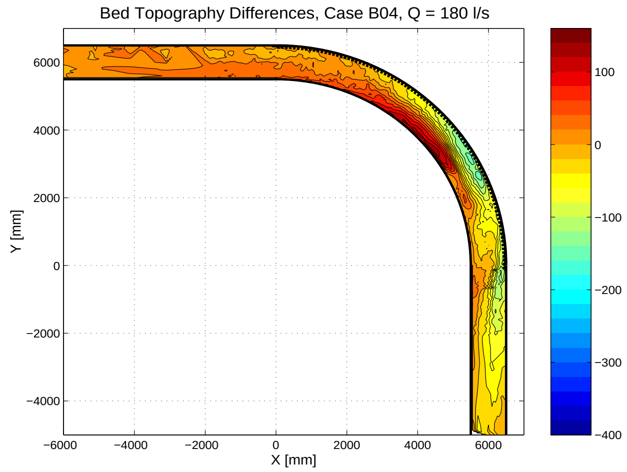
Table 4.2: Bed topography compared to initial bed level - S_0 = 0.50%

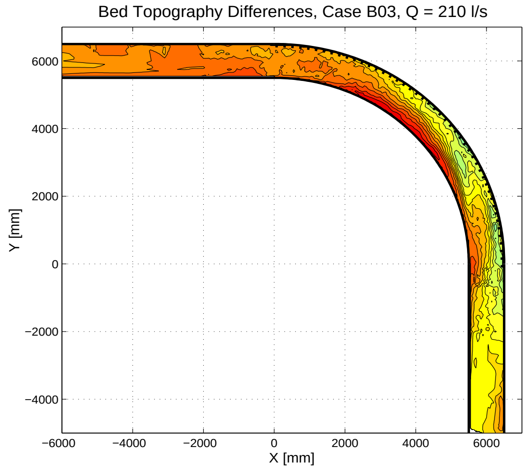
WITH MR SPACING 2°	WITH MR SPACING 1°

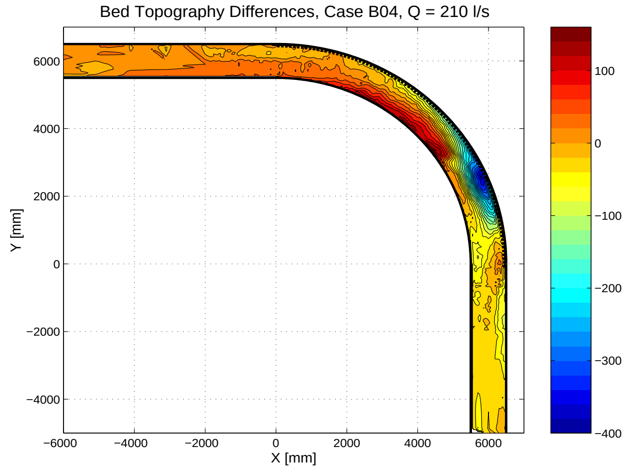












Distances in mm; Equidistance: 20 mm; Linear interpolation

4.3 Channel slope S_0 = 0.70% - mr depth = 20 mm

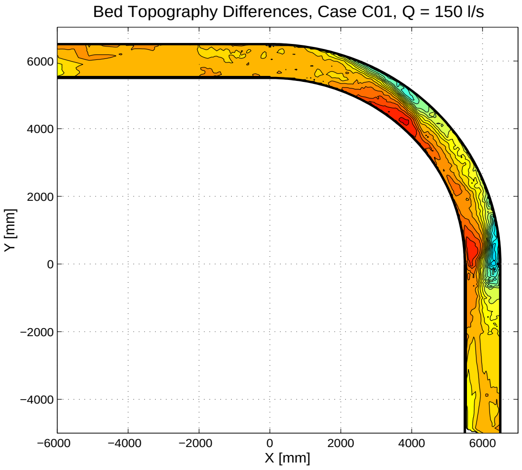
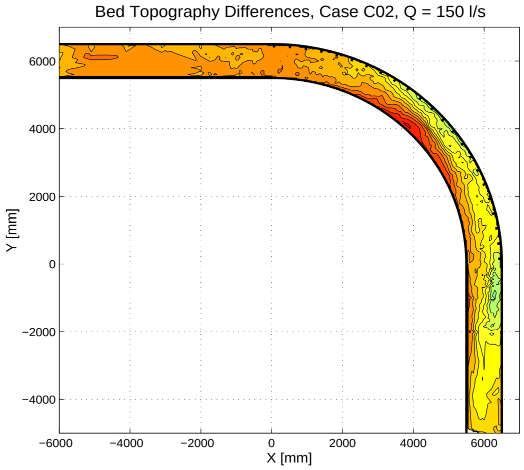
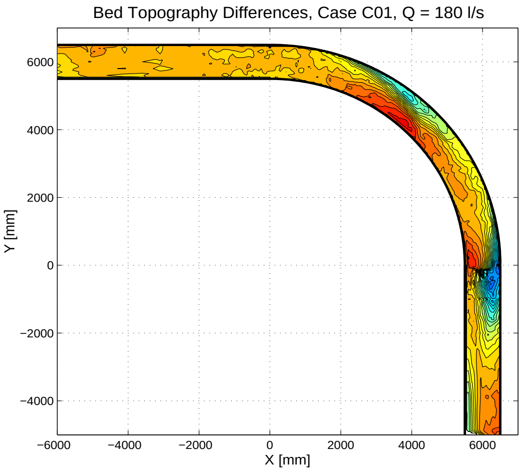
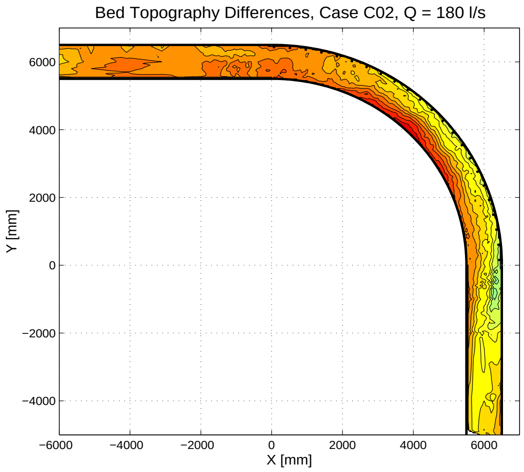
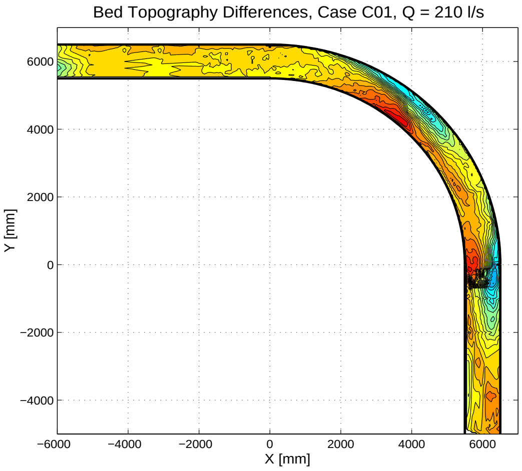
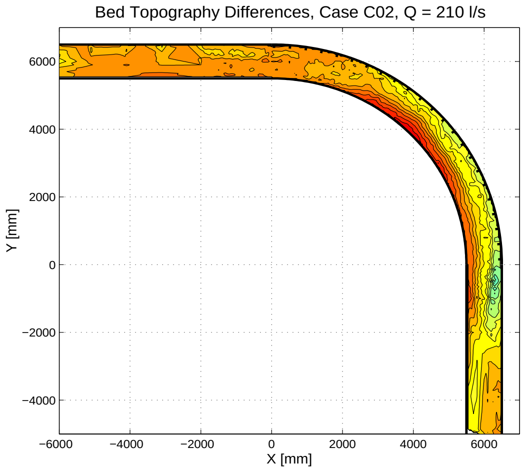
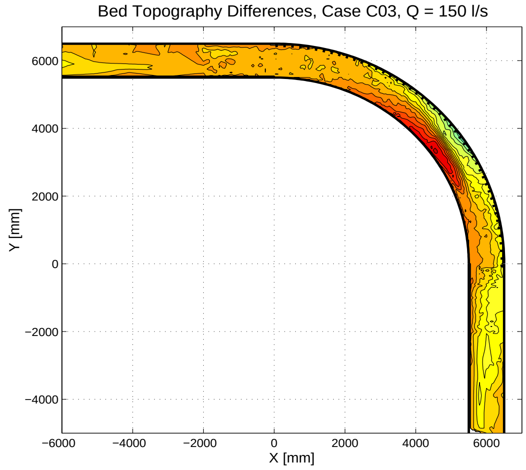
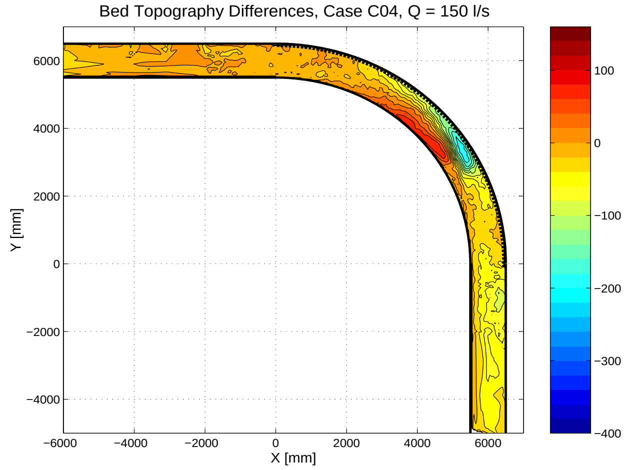
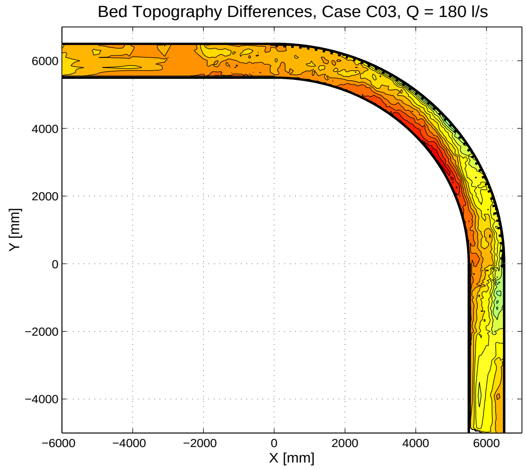
Q [L/S]	WITHOUT MR	WITH MR SPACING 4°
150		
180		
210		

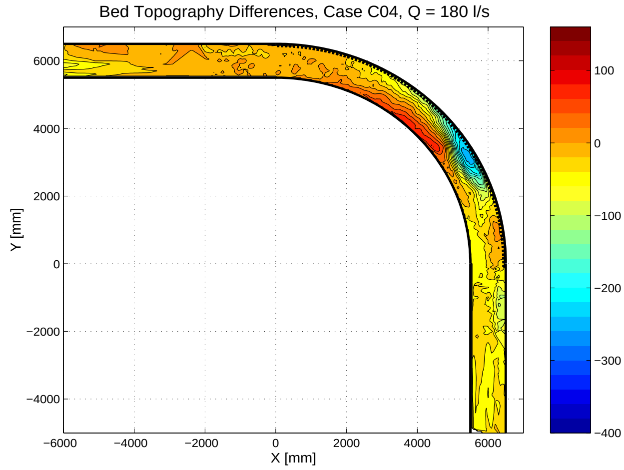
Table 4.3: Bed topography compared to initial bed level - S_0 = 0.70%

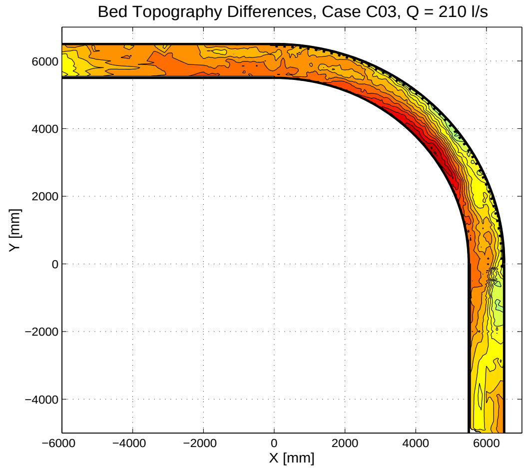
WITH MR SPACING 2°	WITH MR SPACING 1°

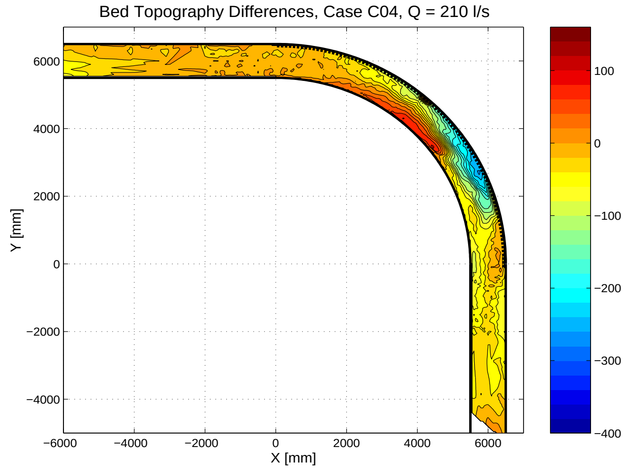












Distances in mm; Equidistance: 20 mm; Linear interpolation

4.4 Channel slope S_0 = 0.50% - mr depth = 40 mm

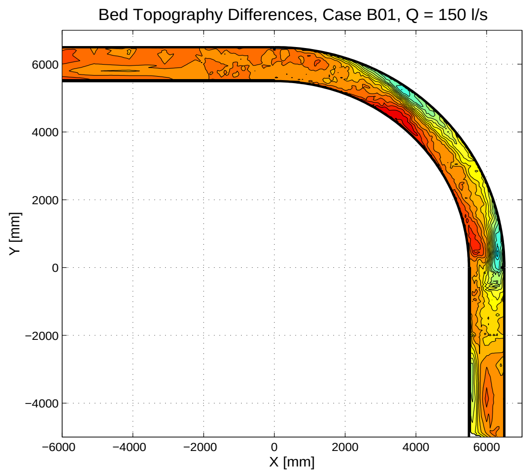
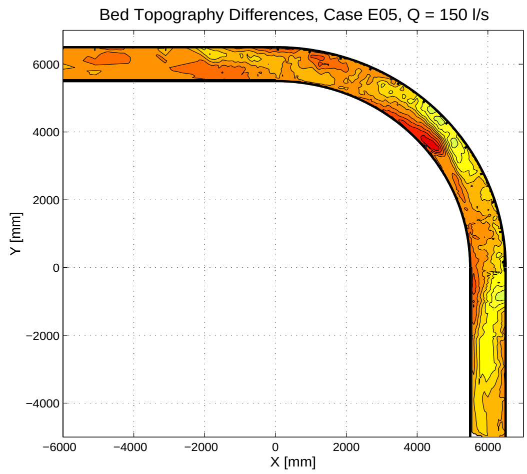
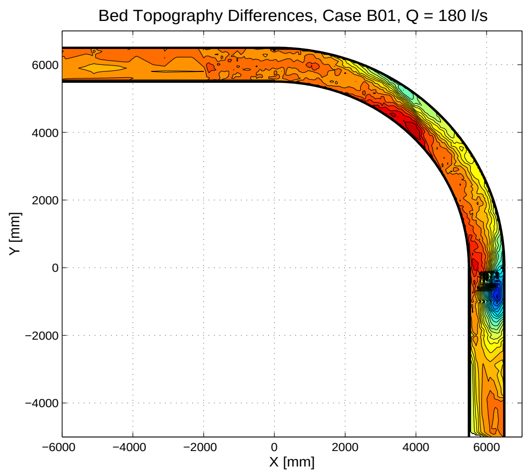
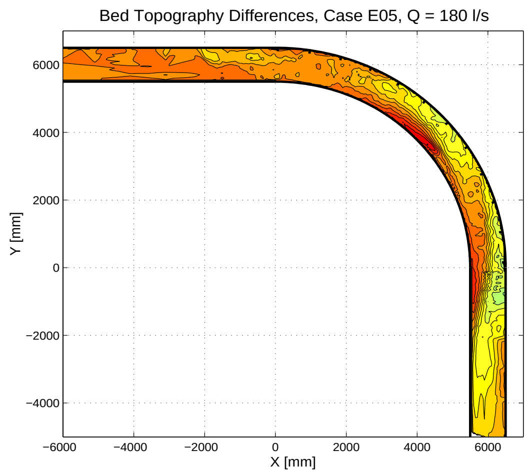
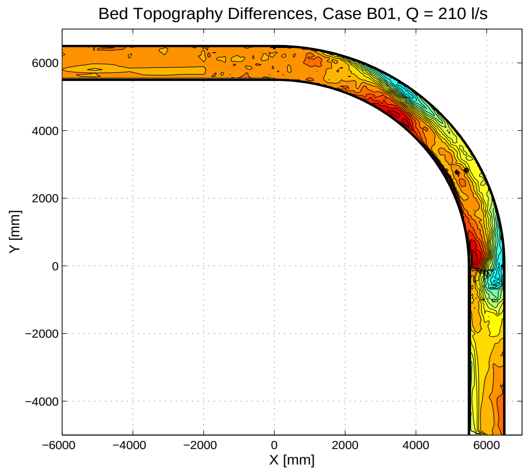
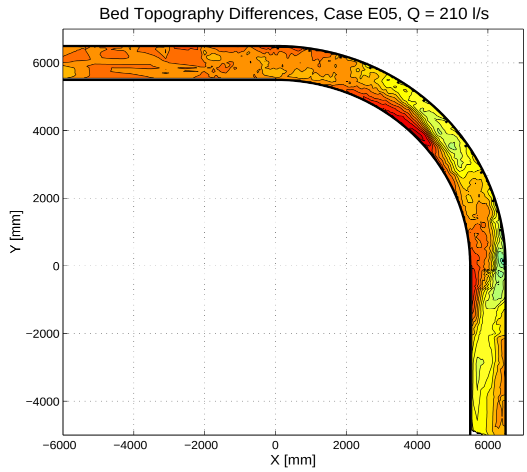
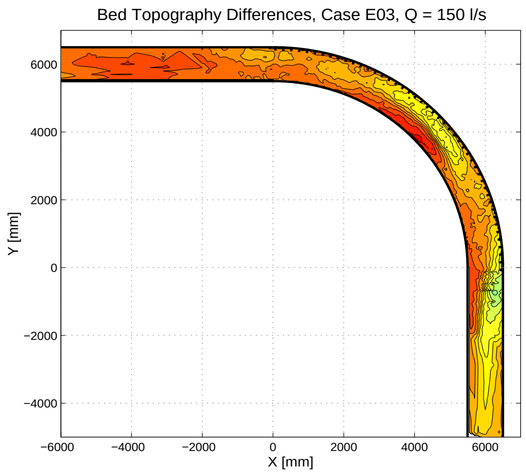
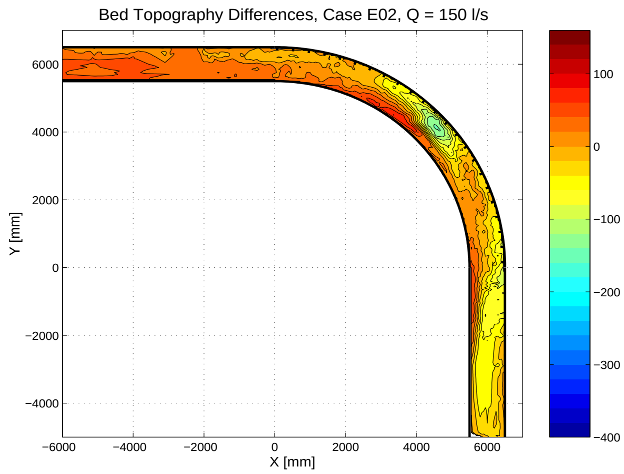
Q [L/S]	WITHOUT MR (COPY OF B01)	WITH MR SPACING 8°
150		
180		
210		

Table 4.4: Bed topography compared to initial bed level - S_0 = 0.50% (thick mr)

<table>
<tr><th>WITH MR
SPACING 4°</th><th>WITH MR
SPACING 2°</th></tr>
<tr><td>
</td><td>
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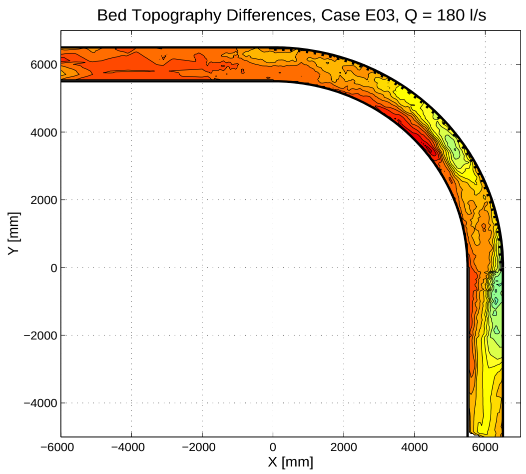
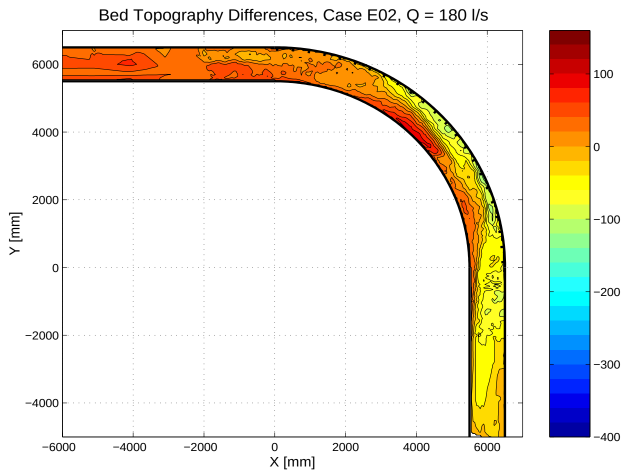
<tr><td>
</td><td>
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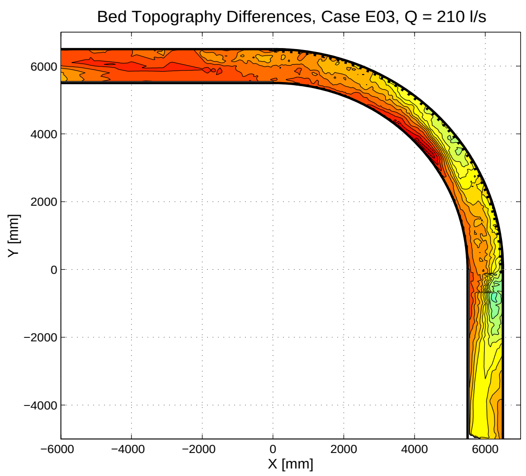
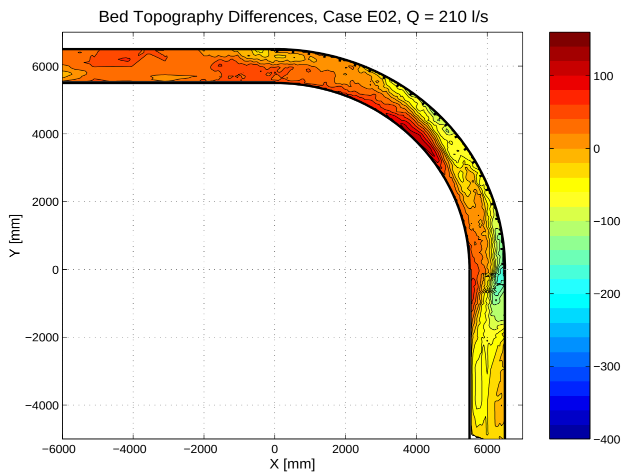
<tr><td>
</td><td>
</td></tr>
</table>

Distances in mm; Equidistance: 20 mm; Linear interpolation

4.5 *Long term experience* - $S_0 = 0.50\%$, $e_d = 40$ mm

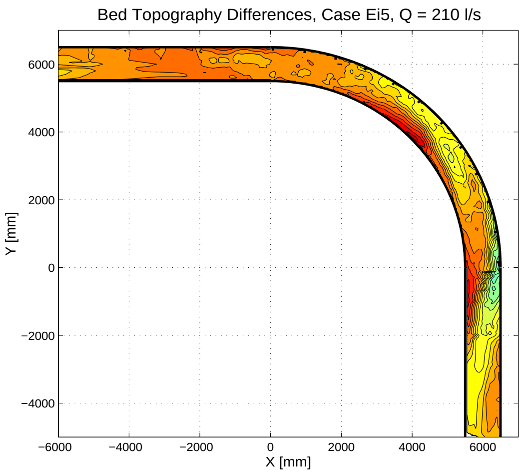
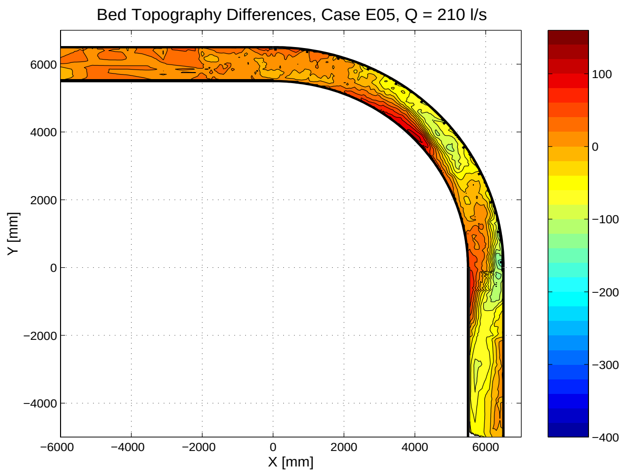
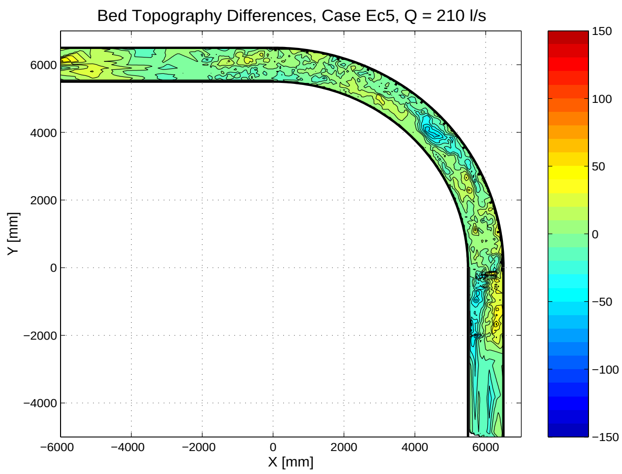
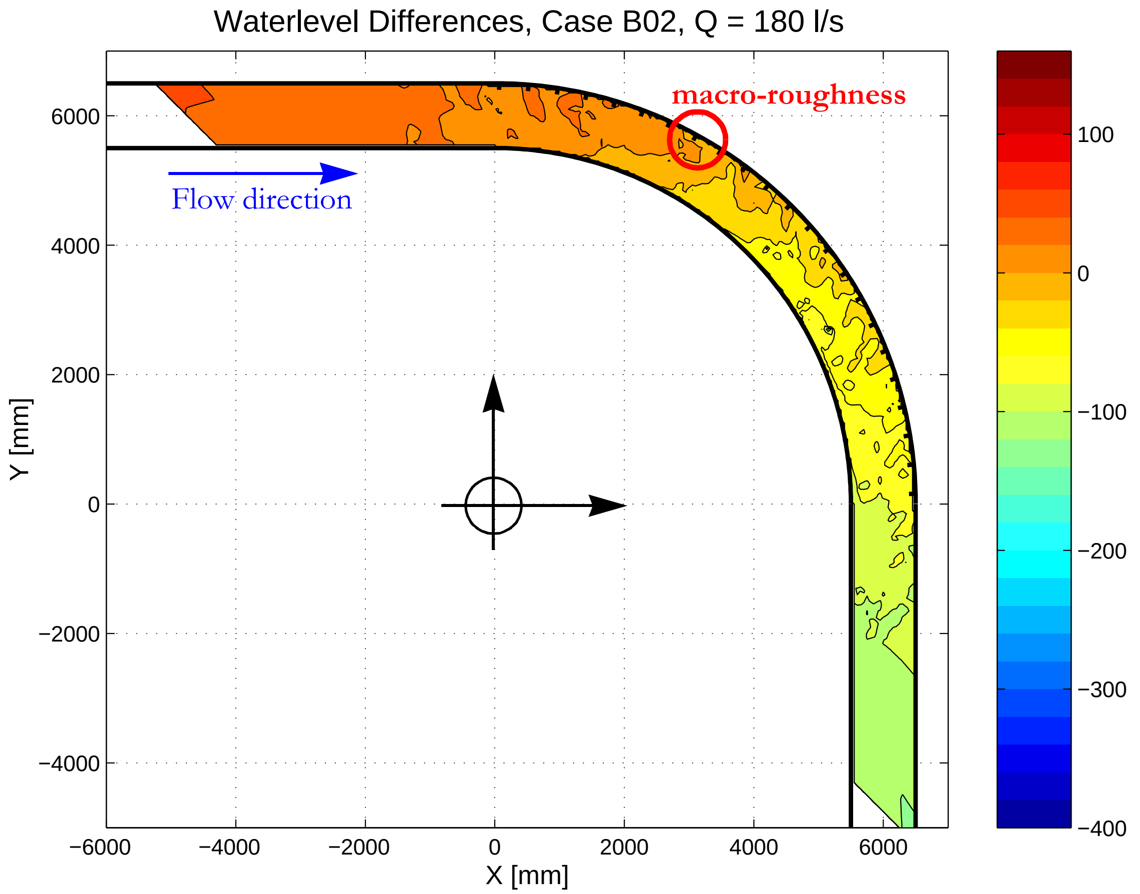
<table>
<tr><th>Q
[L/S]</th><th>INTERMEDIATE MEASUREMENT
AFTER ~13 HOURS</th><th>FINAL MEASUREMENT
AFTER ~27 HOURS</th></tr>
<tr><td>210</td><td>
</td><td>
</td></tr>
<tr><td>210</td><td>comparison
between intermediate and
final measurement
→</td><td>
</td></tr>
</table>

Table 4.5: Bed topography compared to initial bed level - Long term experience
$S_0 = 0.50\%$ (thick mr) - mr-spacing = 8° - Q = 210 l/s
Distances in mm; Equidistance: 20 mm; Linear interpolation

APPENDIX 5

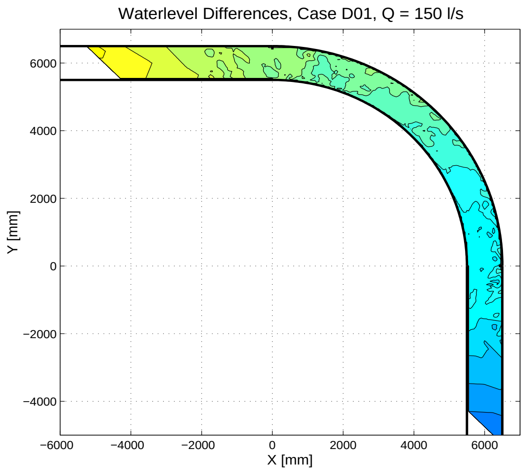
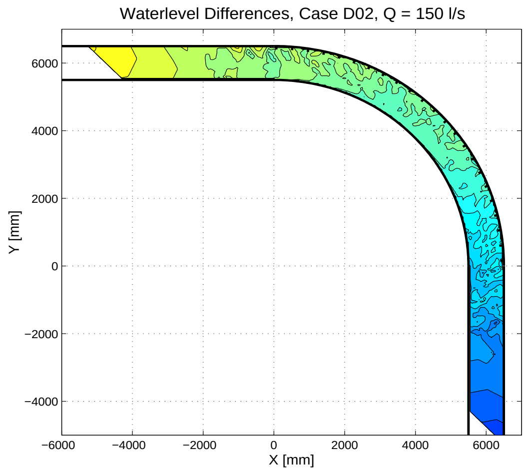
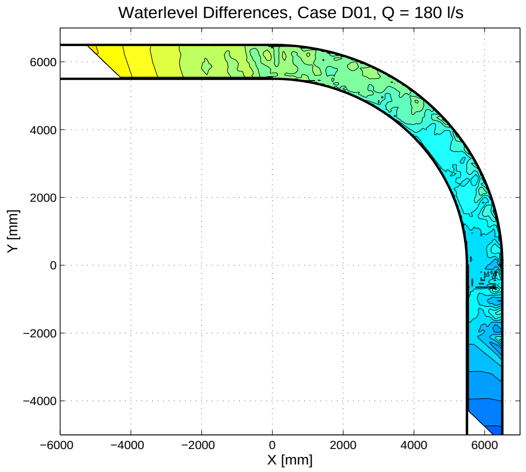
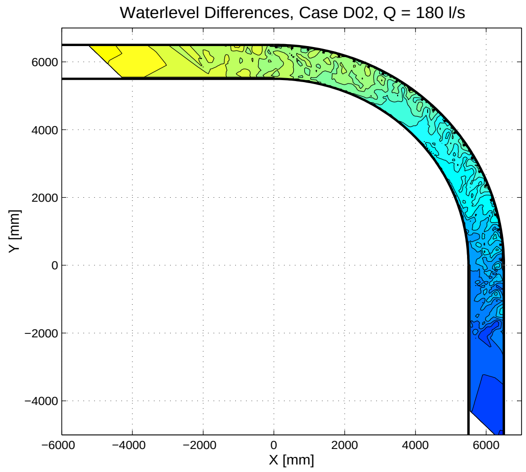
WATER SURFACE COMPARED TO MEAN WATER LEVEL

This Appendix gives the final water surface compared to a horizontal average surface over the whole channel (average of all data points).



Additional information can be found in the report in Chapter 5.3.1 and 6.2.2.

5.1 Channel slope S_0 = 0.35% - mr depth = 20 mm

<table>
<tr><th>Q
[L/S]</th><th>WITHOUT MR</th><th>WITH MR
SPACING 4°</th></tr>
<tr><td>150</td><td>
</td><td>
</td></tr>
<tr><td>180</td><td>
</td><td>
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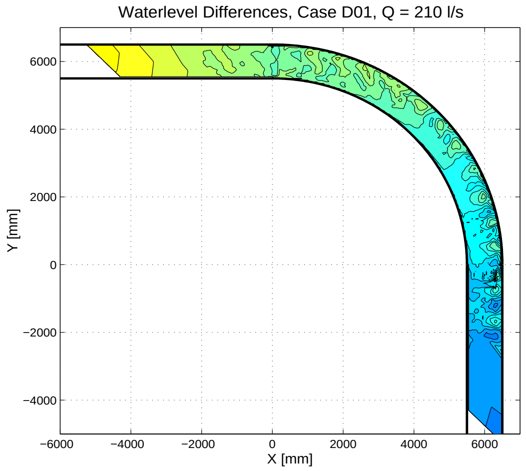
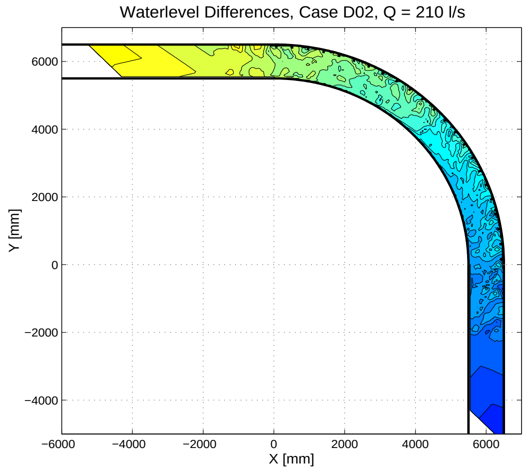
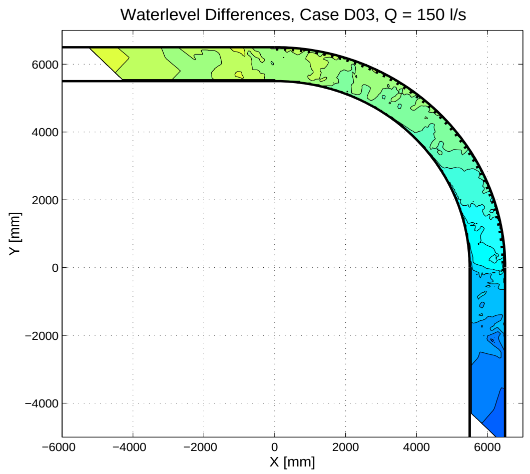
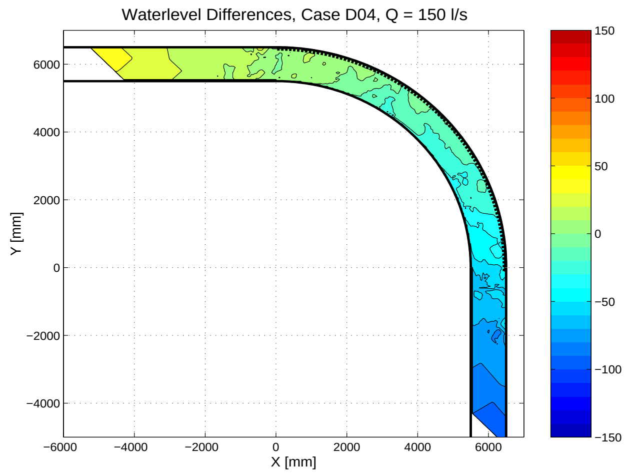
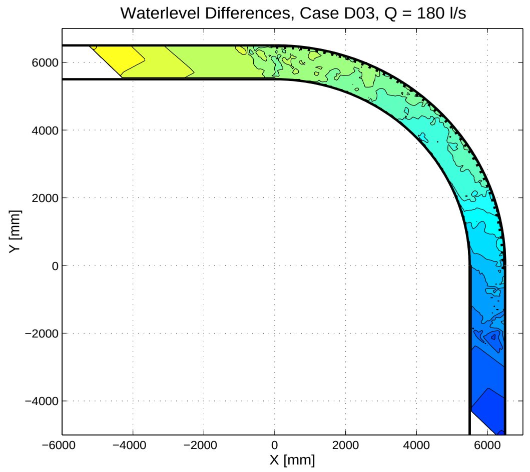
<tr><td>210</td><td>
</td><td>
</td></tr>
</table>

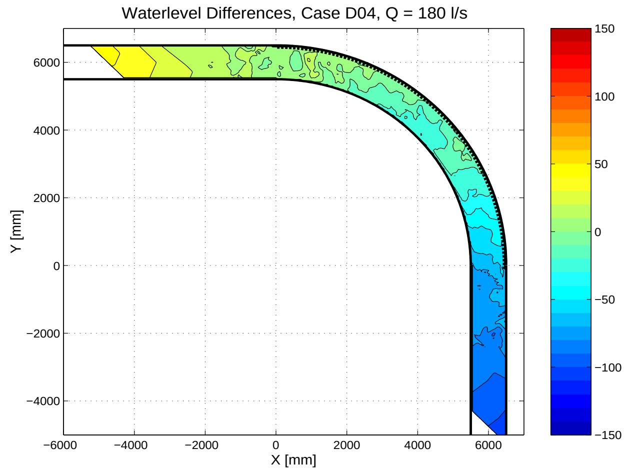
Table 5.1: Water surface compared to mean water level - S_0 = 0.35%

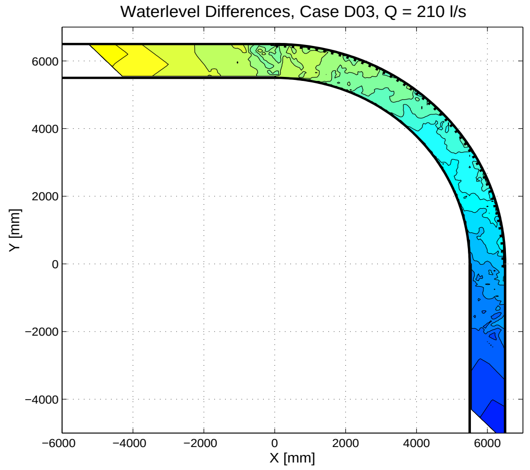
WITH MR SPACING 2°	WITH MR SPACING 1°

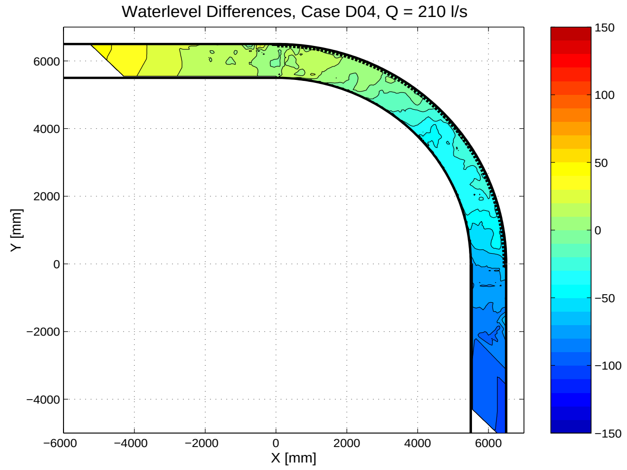












Distances in mm; Equidistance: 10 mm; Linear interpolation

5.2 Channel slope S_0 = 0.50% - mr depth = 20 mm

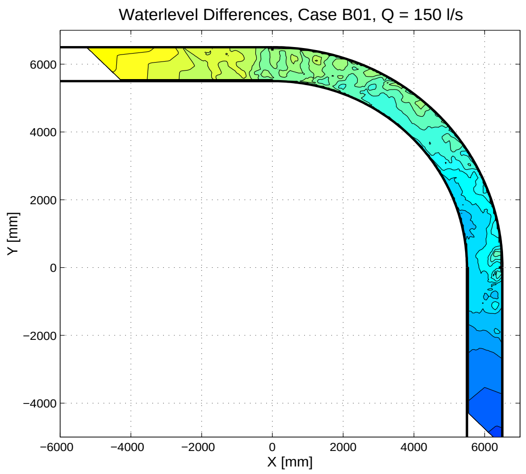
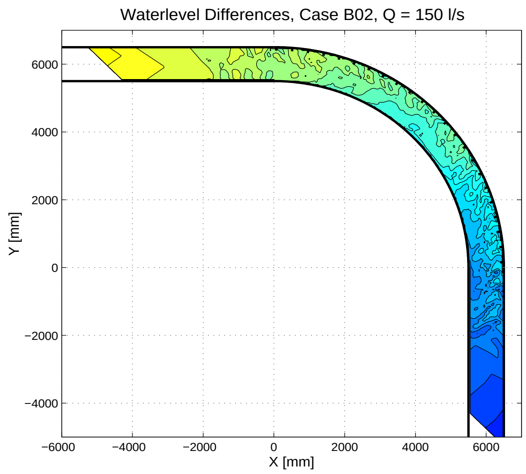
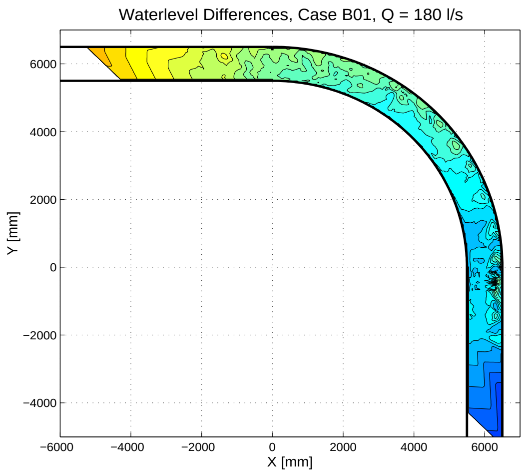
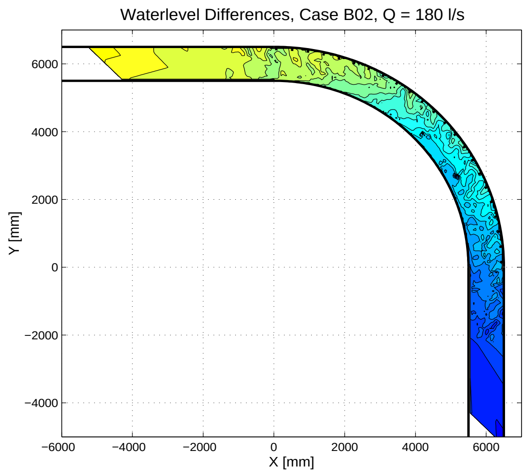
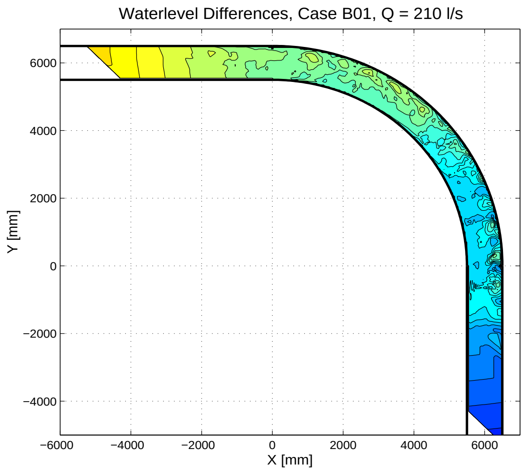
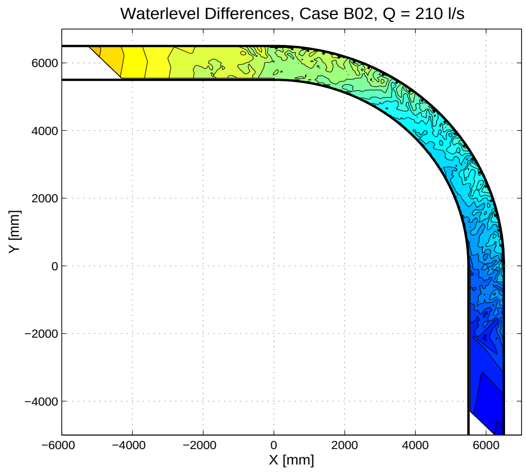
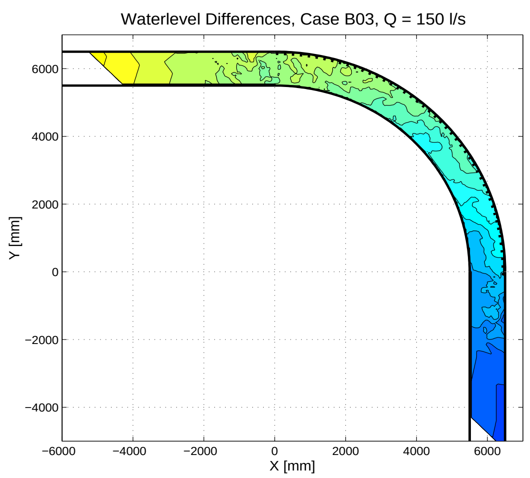
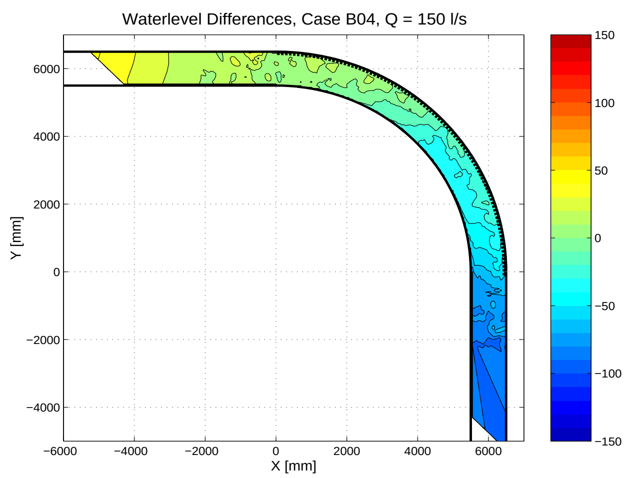
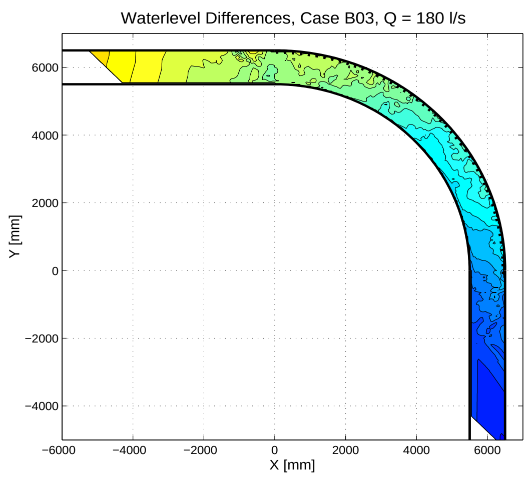
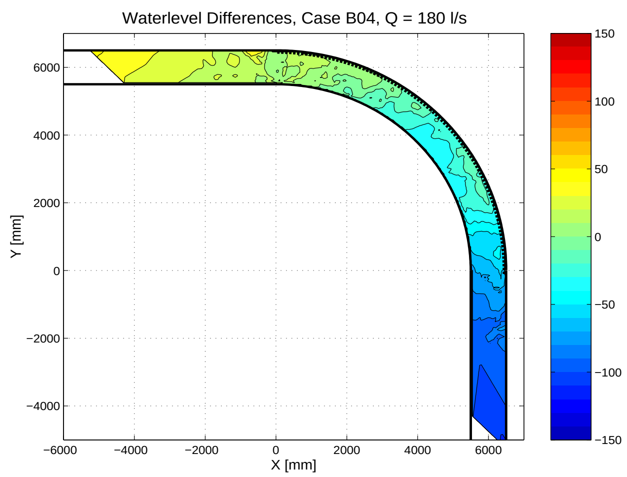
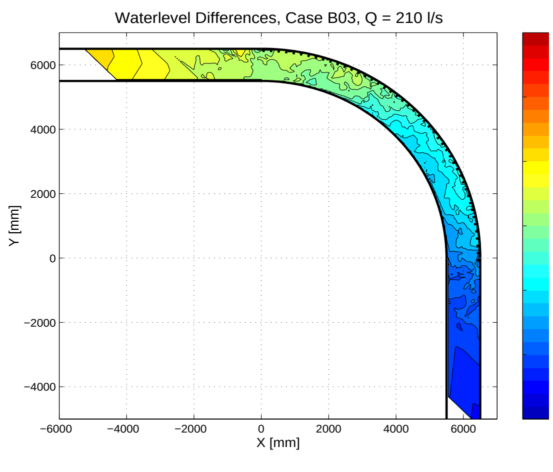
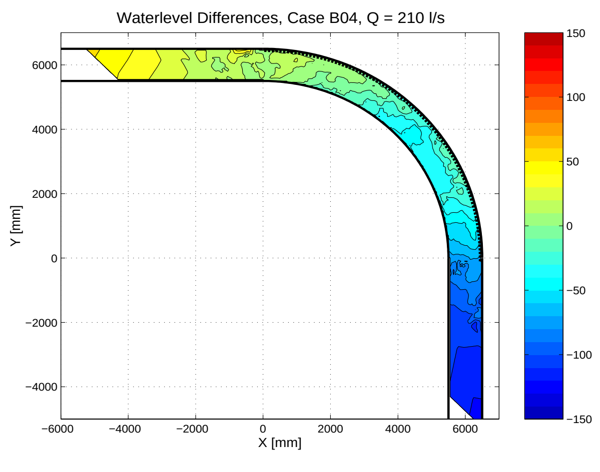
Q [L/S]	WITHOUT MR	WITH MR SPACING 4°
150		
180		
210		

Table 5.2: Water surface compared to mean water level - S_0 = 0.50%

WITH MR SPACING 2°	WITH MR SPACING 1°
	
	
	

Distances in mm; Equidistance: 10 mm; Linear interpolation

5.3 Channel slope S_0 = 0.70% - mr depth = 20 mm

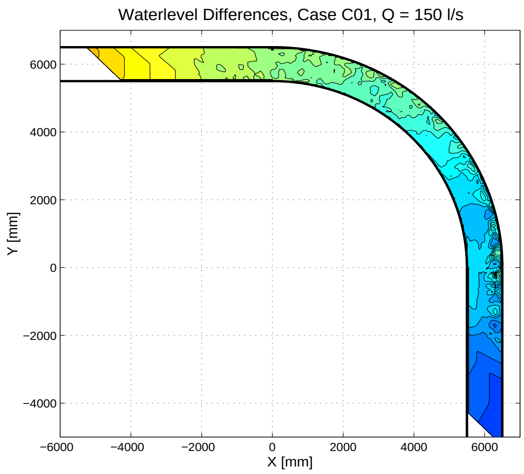
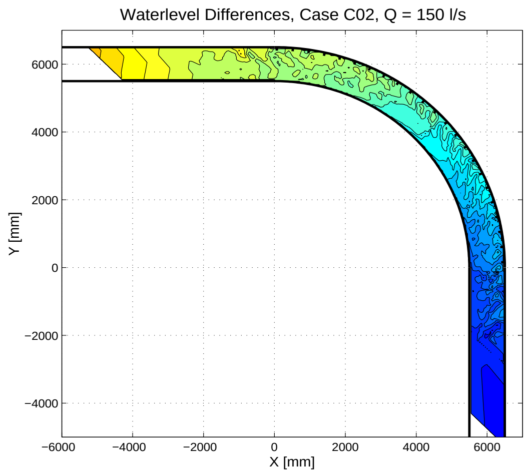
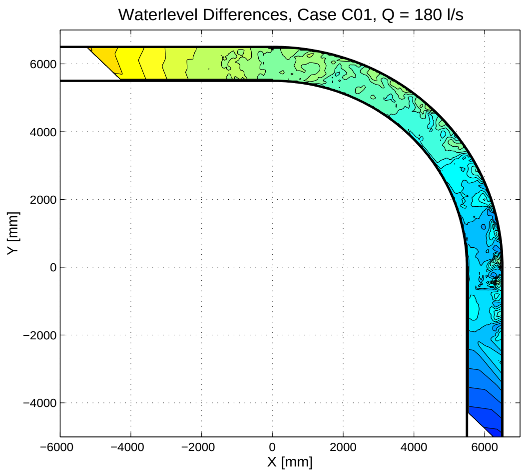
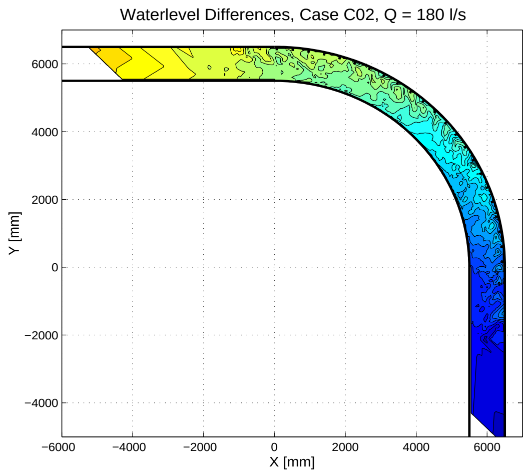
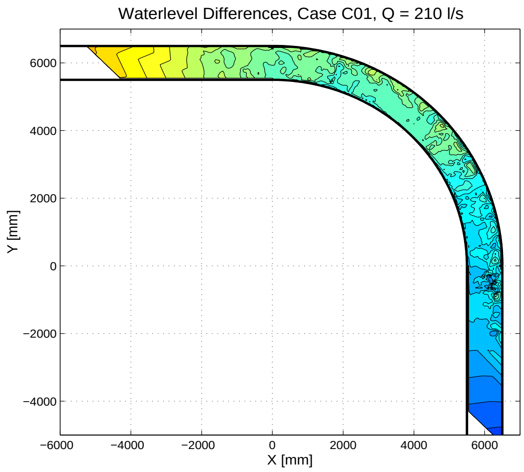
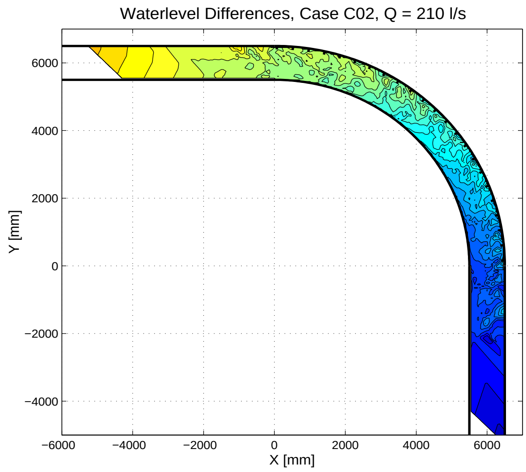
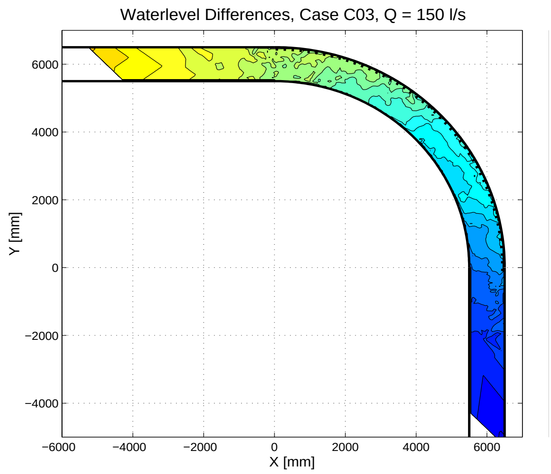
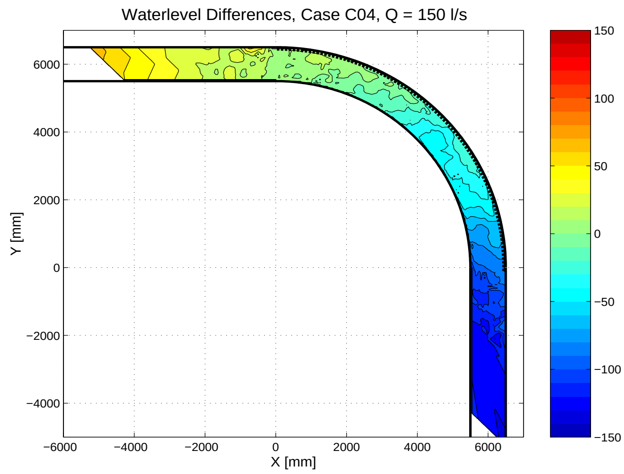
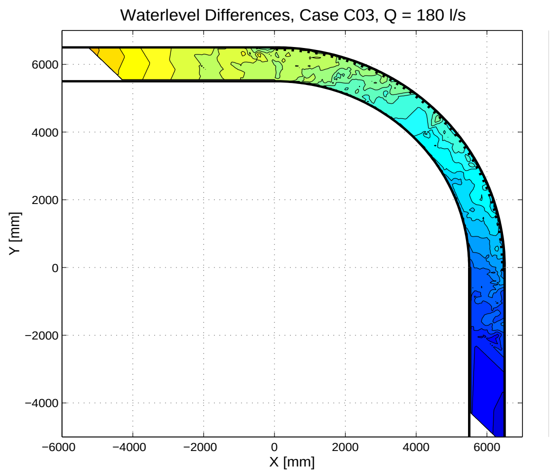
Q [L/S]	WITHOUT MR	WITH MR SPACING 4°
150		
180		
210		

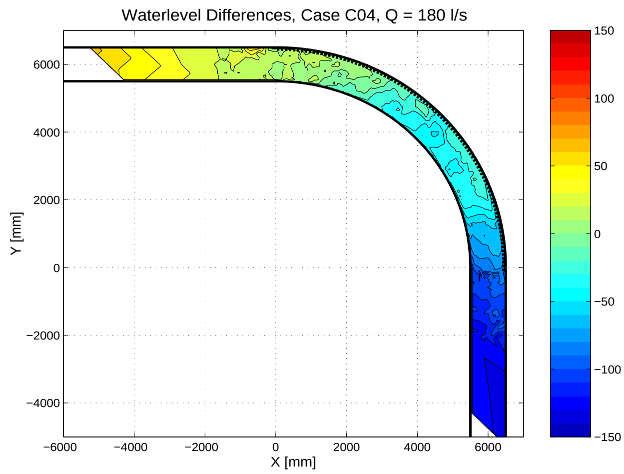
Table 5.3: Water surface compared to mean water level - S_0 = 0.70%

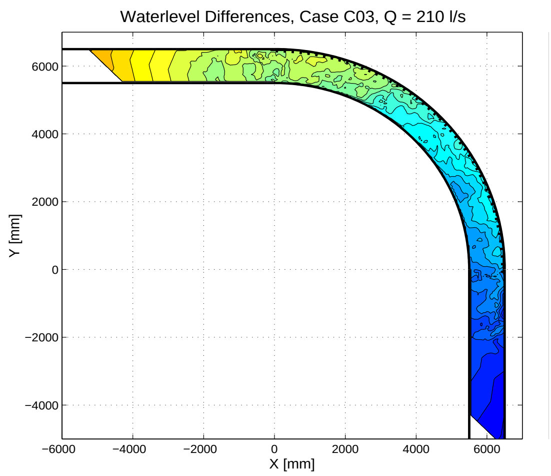
WITH MR SPACING 2°	WITH MR SPACING 1°

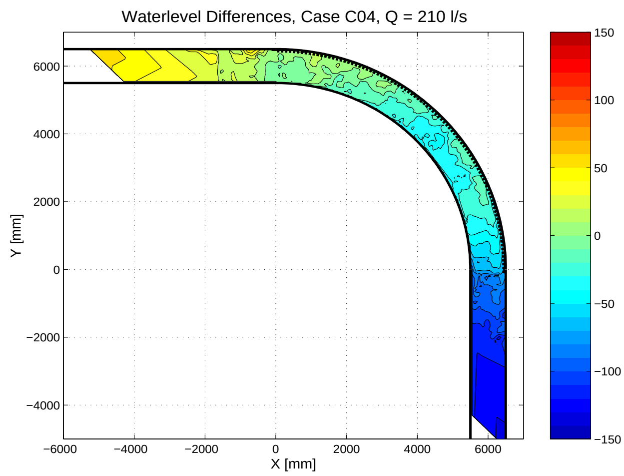












Distances in mm; Equidistance: 10 mm; Linear interpolation

5.4 Channel slope S_0 = 0.50% - mr depth = 40 mm

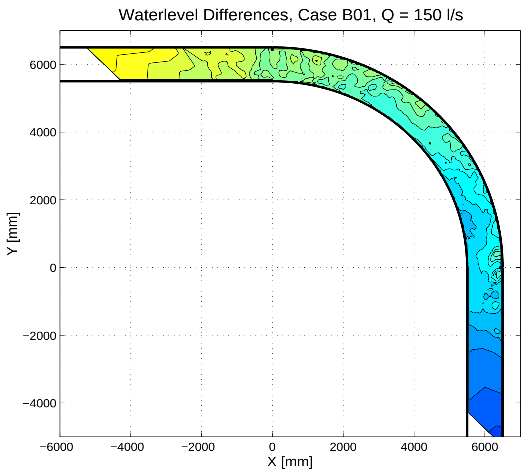
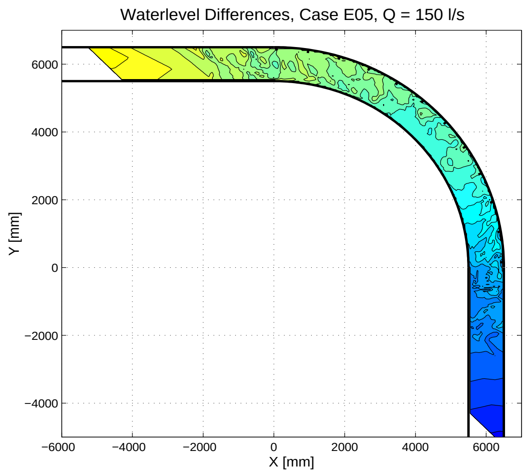
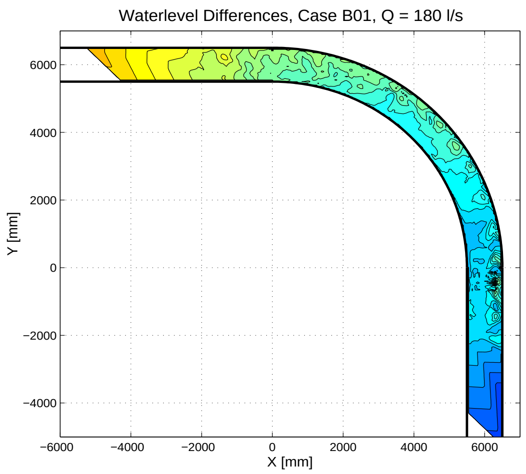
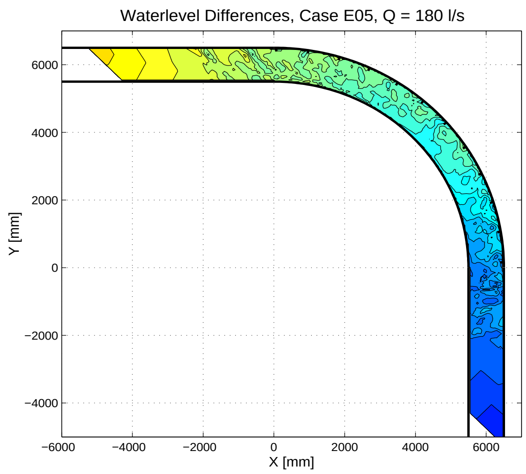
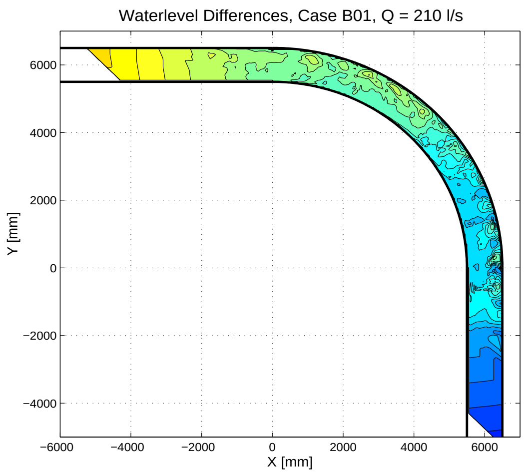
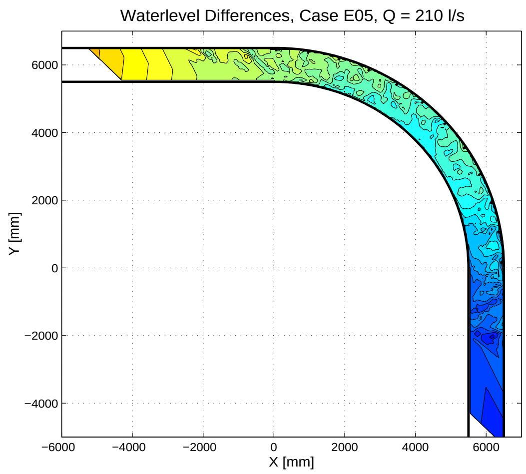
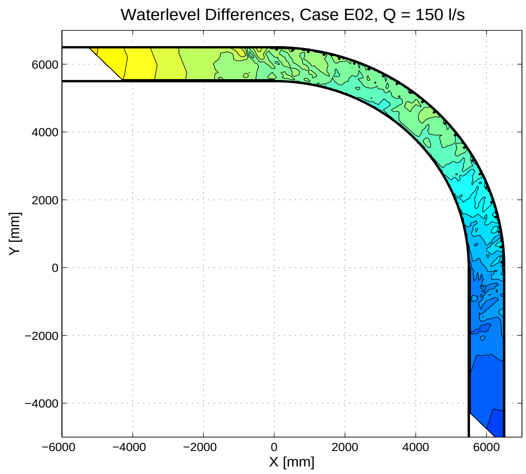
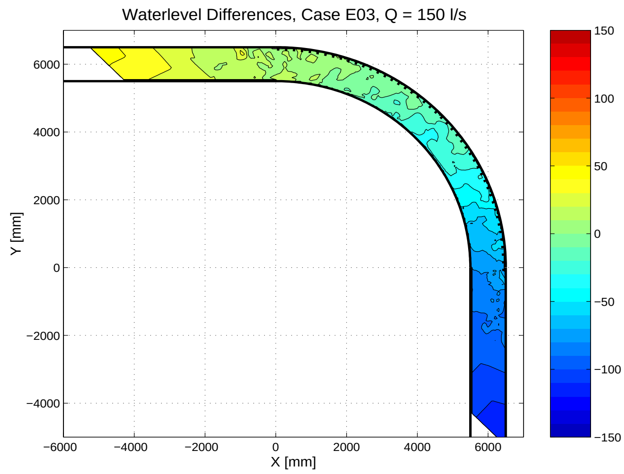
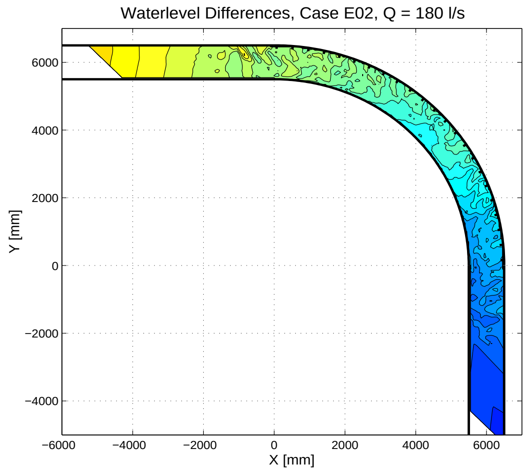
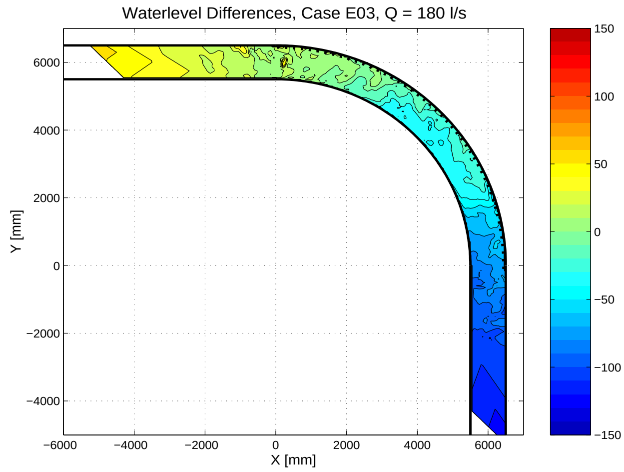
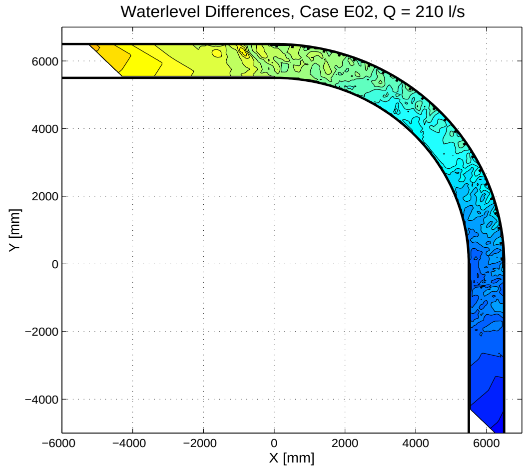
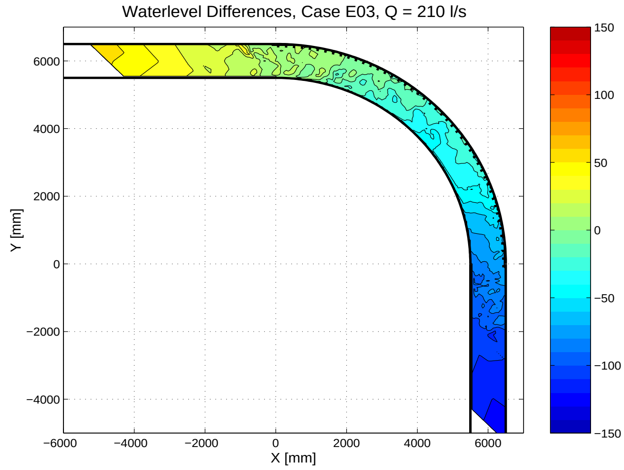
Q [L/S]	WITHOUT MR	WITH MR SPACING 8°
150		
180		
210		

Table 5.4: Water surface compared to mean water level - S_0 = 0.50% (thick mr)

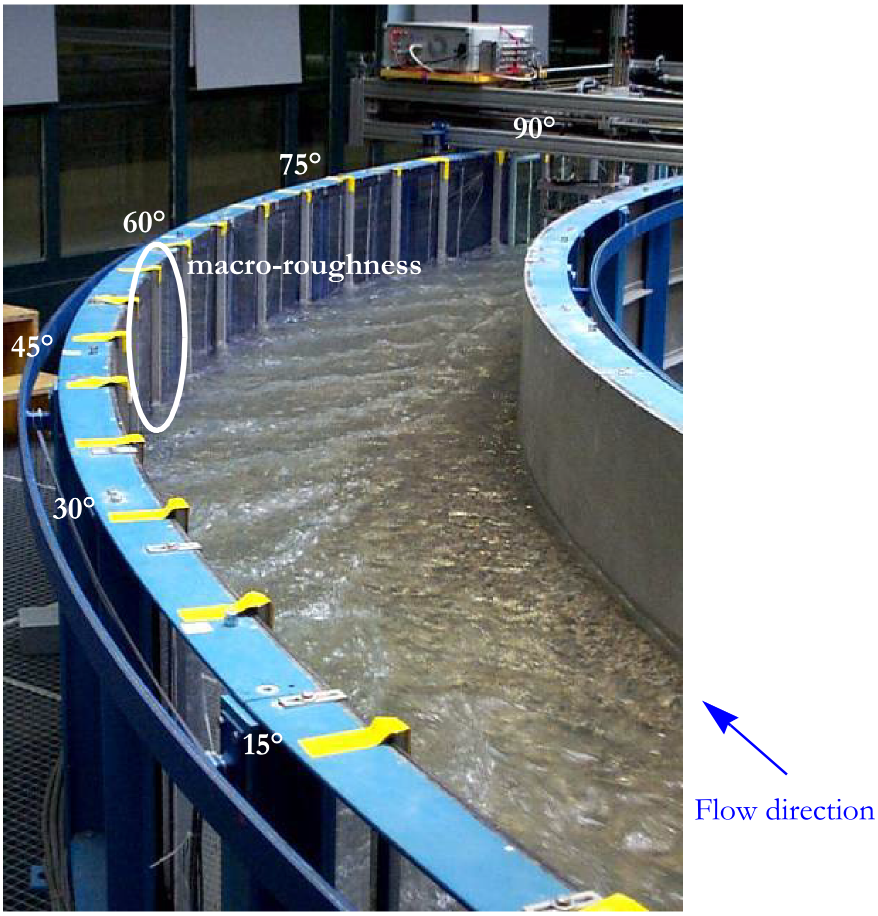
WITH MR SPACING 4°	WITH MR SPACING 2°
	
	
	

Distances in mm; Equidistance: 10 mm; Linear interpolation

APPENDIX 6

WATER SURFACE VIEWS

This Appendix presents systematic pictures of the water surface in the bend.



Additional information can be found in the report in Chapter 5.3.1 and 6.2.2.

6.1 Channel slope S_0 = 0.35% - mr depth = 20 mm

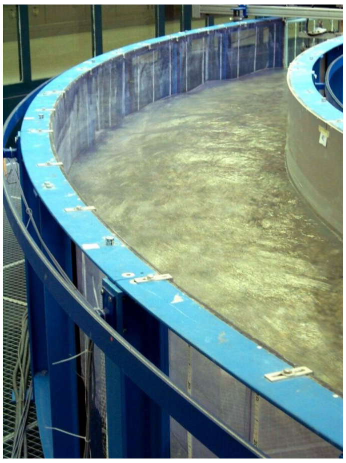
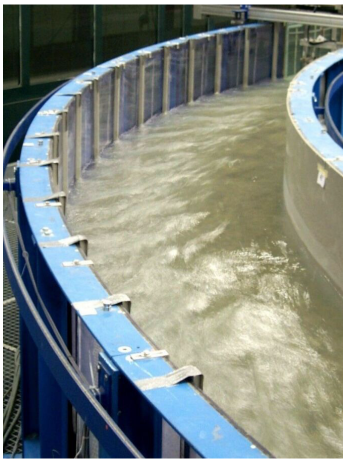
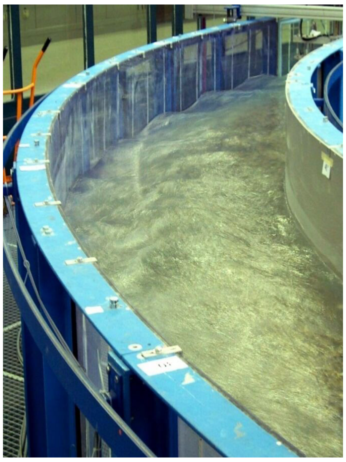
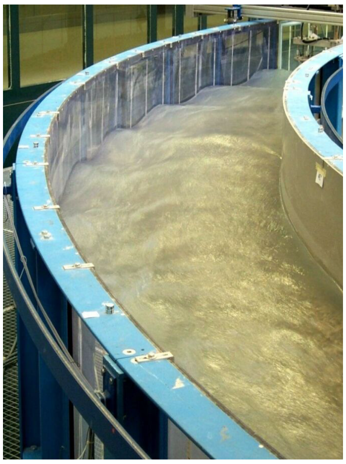
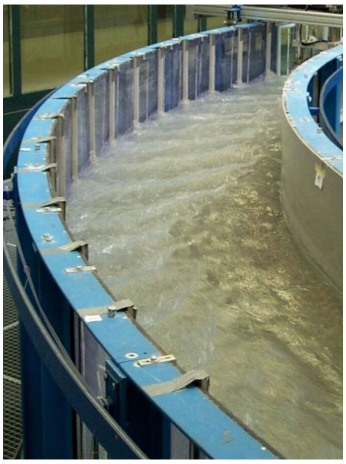
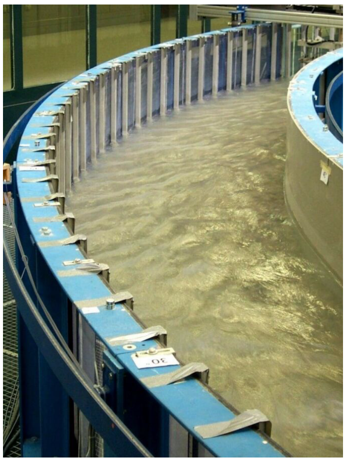
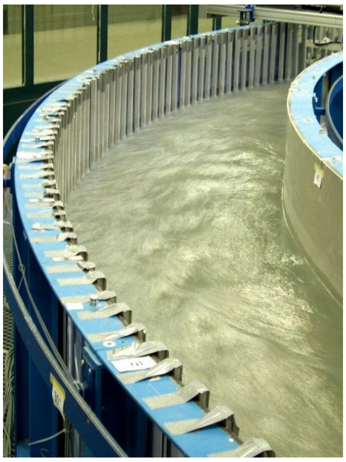
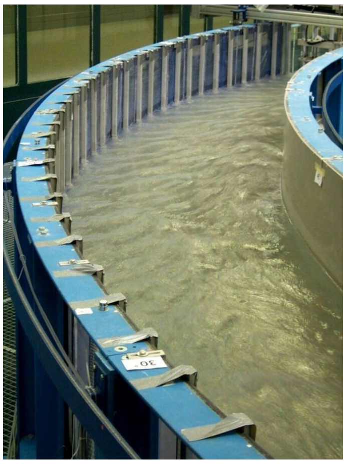
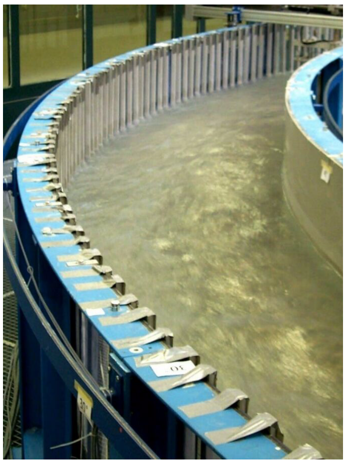
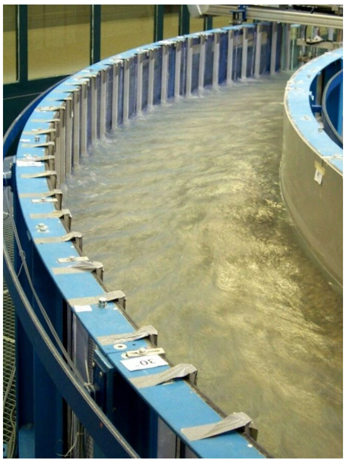
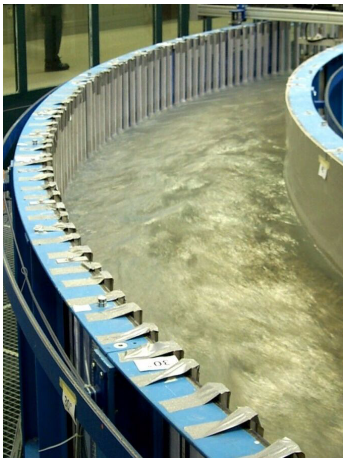
Q [L/S]	WITHOUT MR	WITH MR SPACING 4°
150		
180		
210		

Table 6.1: Water surface views, S_0 = 0.35%, e_d = 20 mm

WITH MR SPACING 2°	WITH MR SPACING 1°
	
	
	

6.2 Channel slope S_0 = 0.50% - mr depth = 20 mm

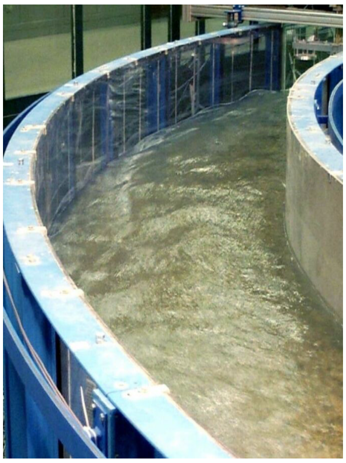
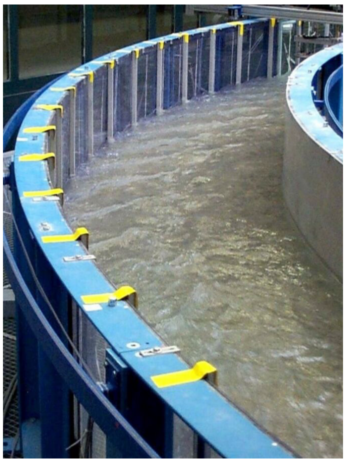
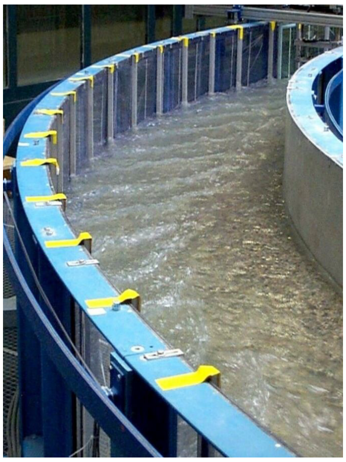
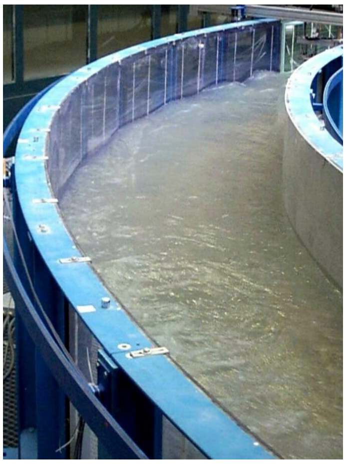
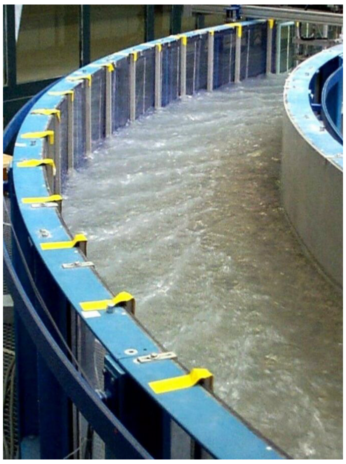
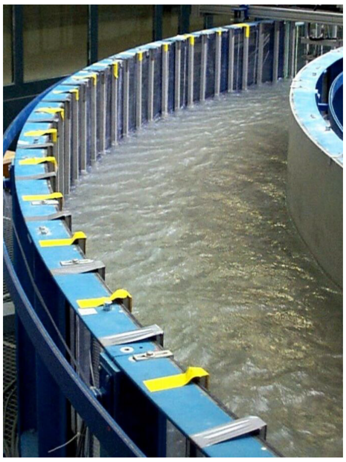
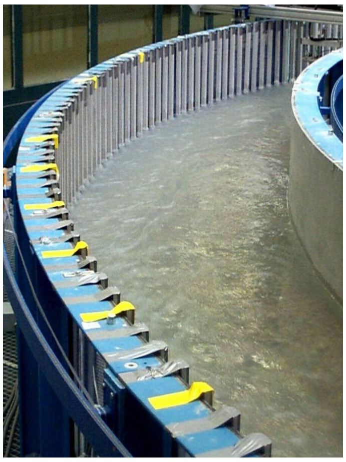
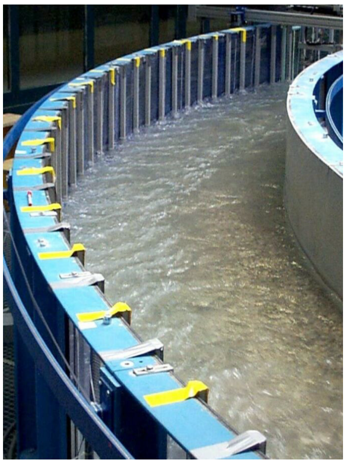
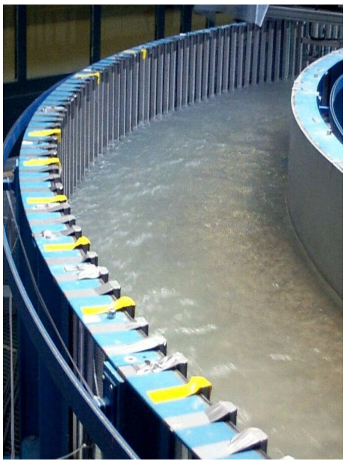
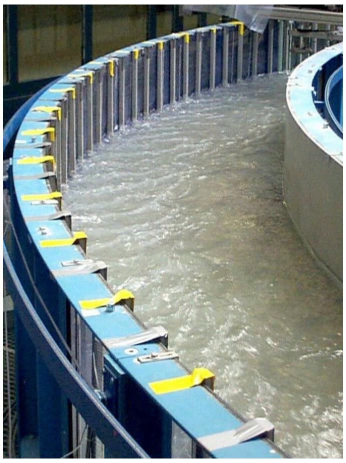
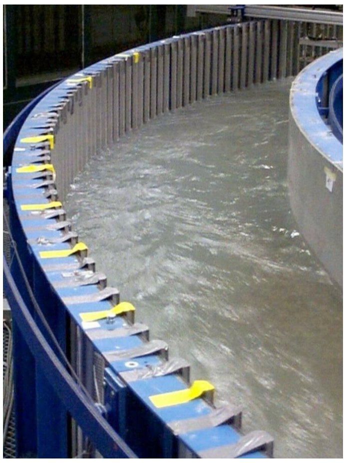
Q [L/S]	WITHOUT MR	WITH MR SPACING 4°
150		
180		
210		

Table 6.2: Water surface views, S_0 = 0.50%, e_d = 20 mm

WITH MR SPACING 2°	WITH MR SPACING 1°
	
	
	

6.3 Channel slope S_0 = 0.70% - mr depth = 20 mm

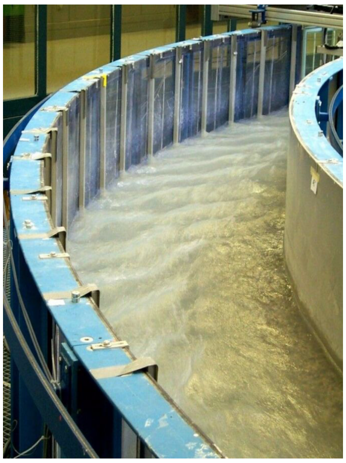
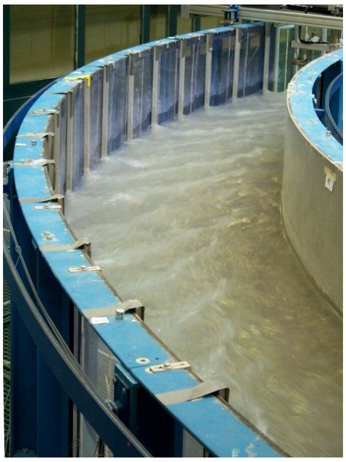
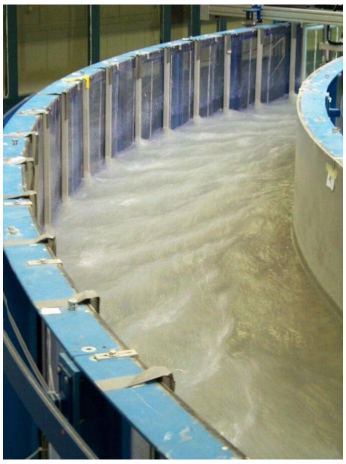
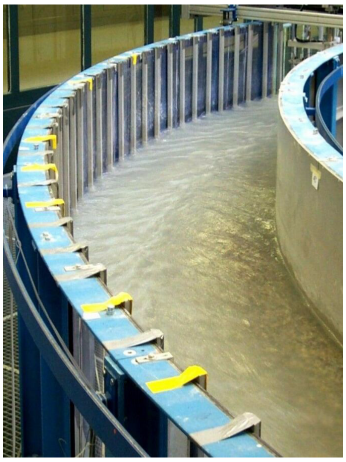
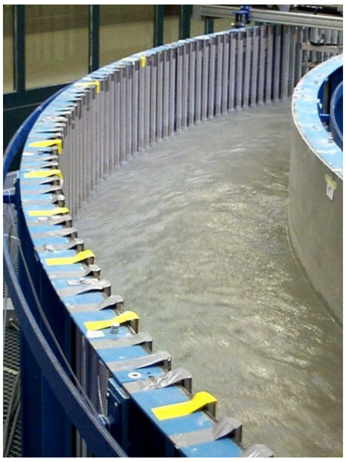
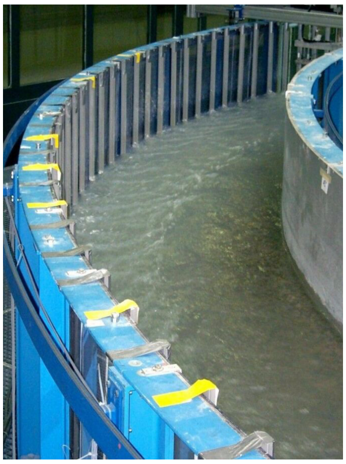
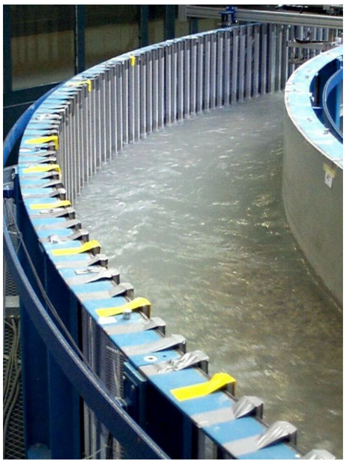
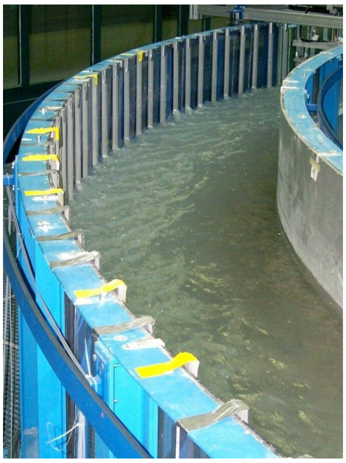
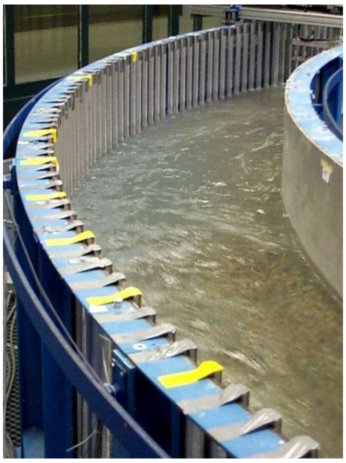
Q [L/S]	WITHOUT MR	WITH MR SPACING 4°
150		
180		
210		

Table 6.3: Water surface views, S_0 = 0.70%, e_d = 20 mm

WITH MR SPACING 2°	WITH MR SPACING 1°
	
	
	

6.4 Channel slope S_0 = 0.50% - mr depth = 40 mm

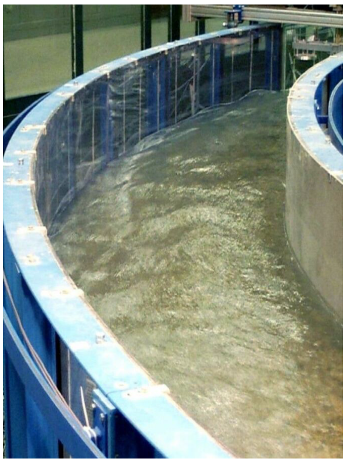
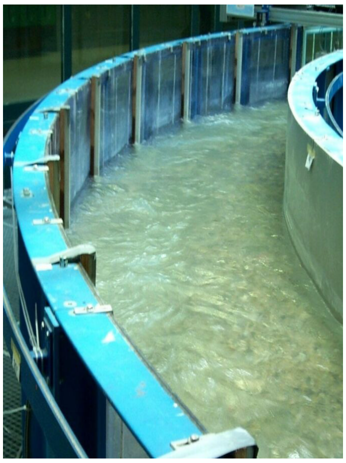
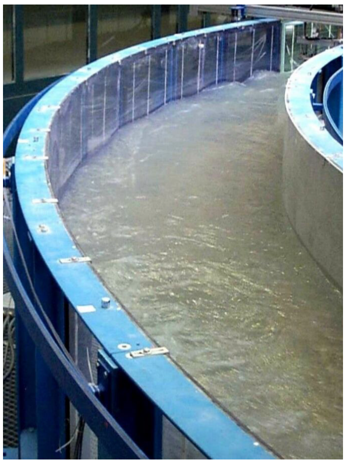
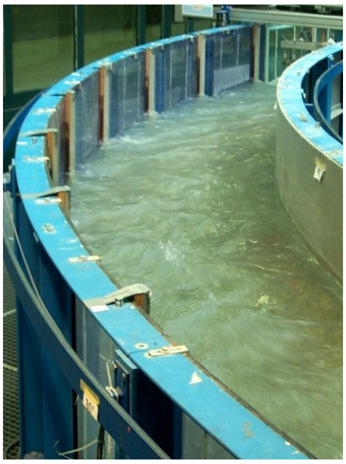
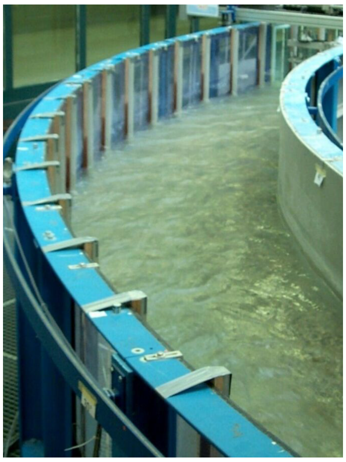
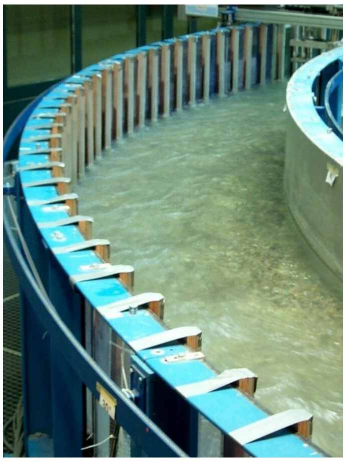
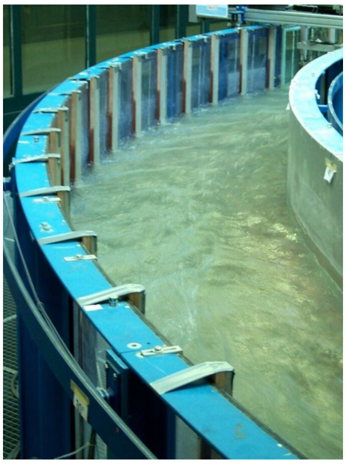
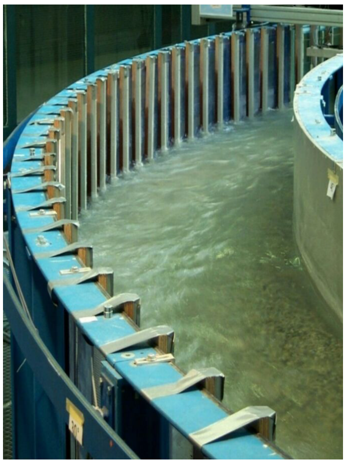
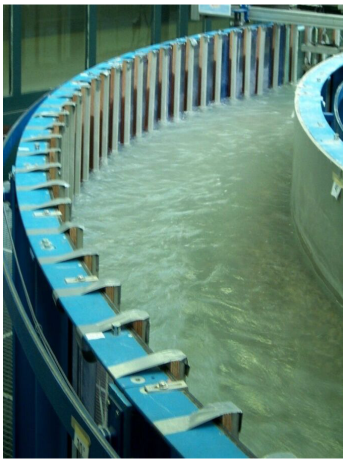
Q [L/S]	WITHOUT MR COPY FROM A.6.2	WITH MR SPACING 8°
150		
180		
210		

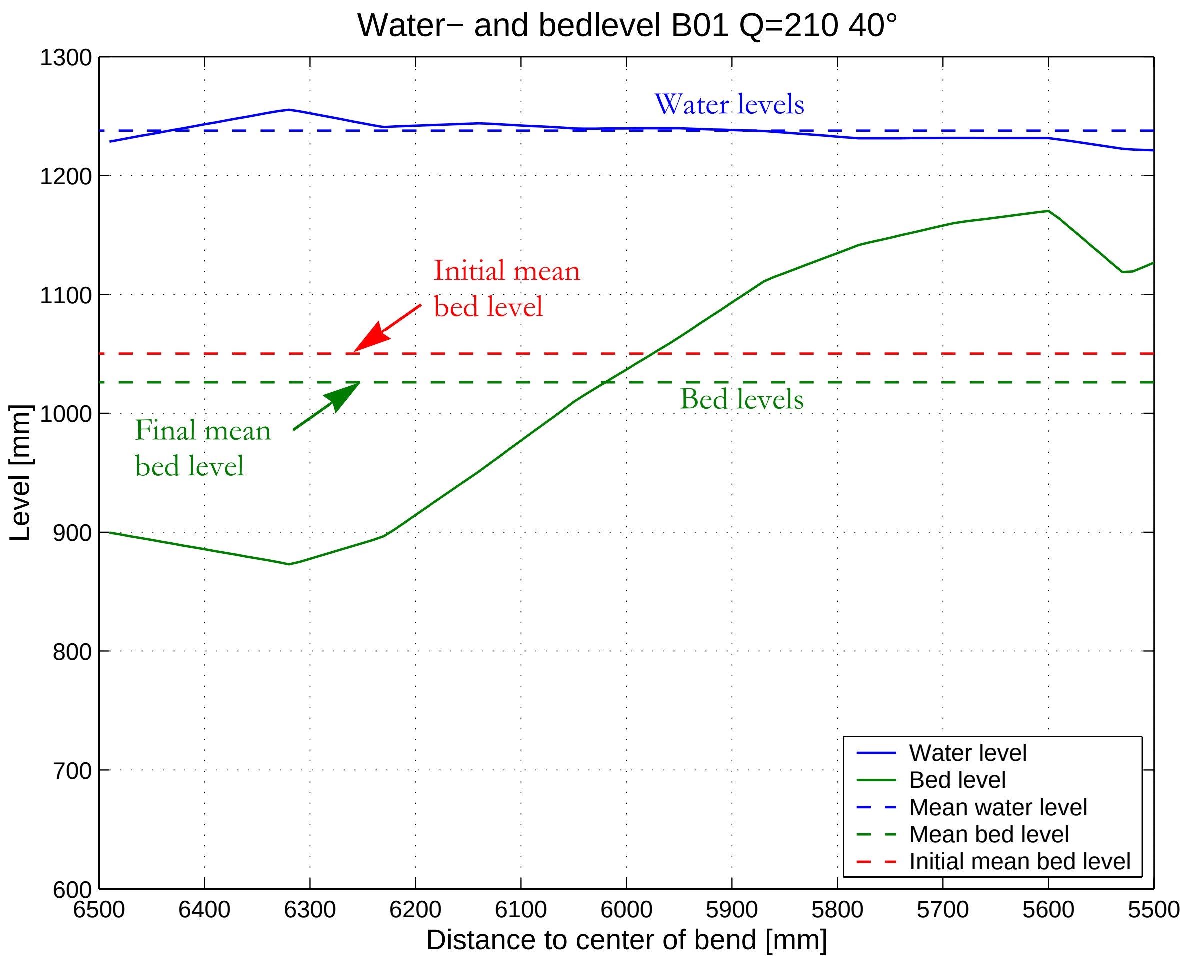
Table 6.4: Water surface views, S_0 = 0.50%, e_d = 40 mm

WITH MR SPACING **4°**	WITH MR SPACING **2°**
	
	
	

APPENDIX 7

EQUILIBRIUM BED AND WATER LEVELS IN SELECTED CROSS SECTIONS

This Appendix gives the final water and bed levels in different cross sections. -1 m indicates the cross section 1 m upstream the bend in the inlet reach.



Additional information can be found in the report in Chapter 5.3.1 and 6.2.

7.1 Cross sections at S_0=0.35%, Q=150 l/s, e_d=20mm

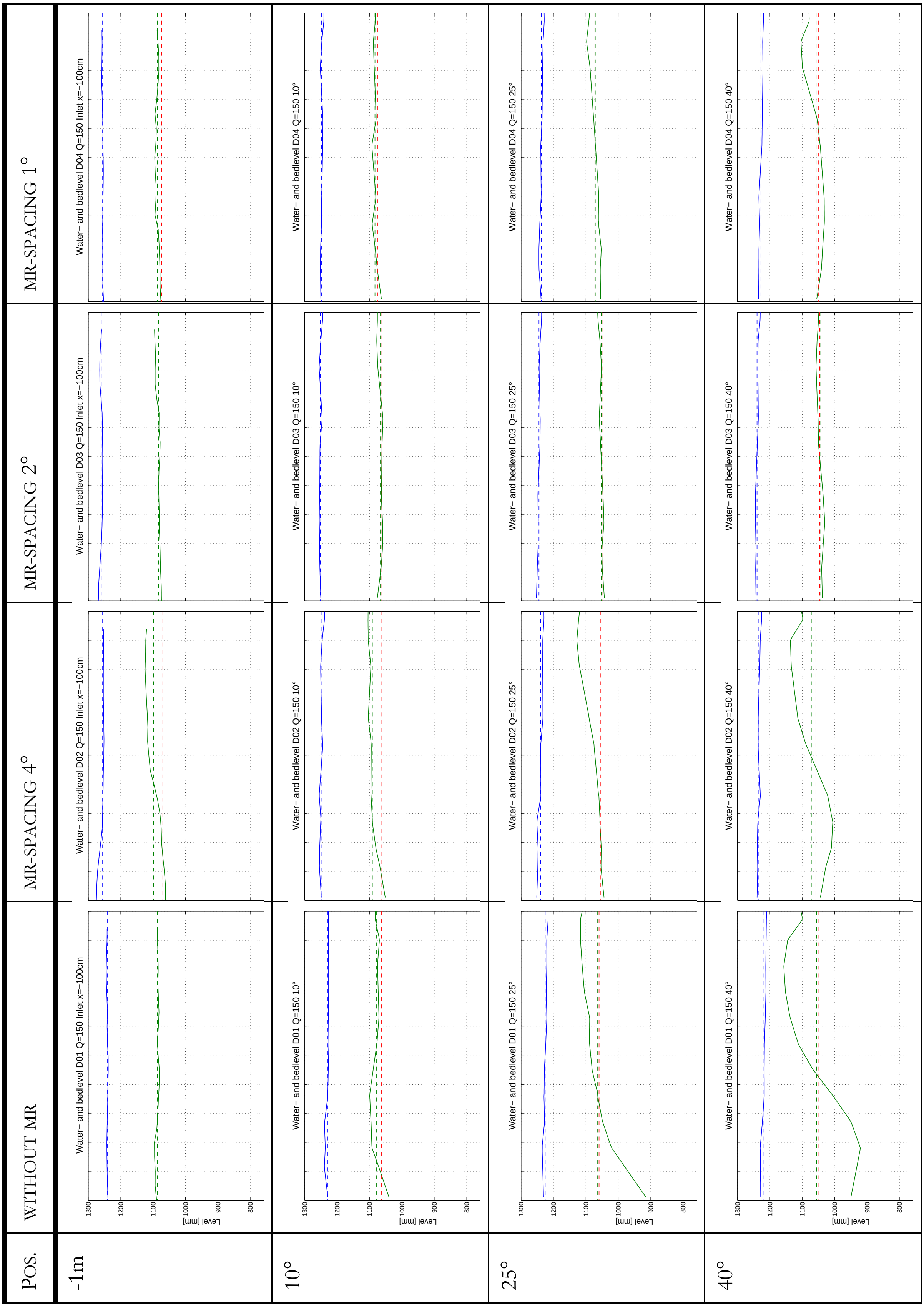


Table 7.1: Cross sections, S_0 = 0.35%, Q=150 l/s, mr-depth = 20 mm

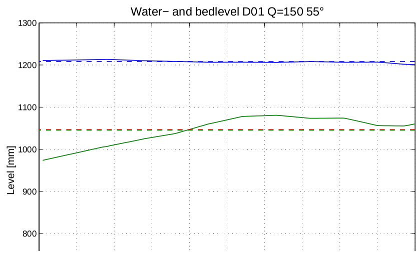
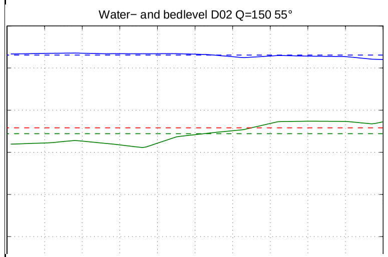
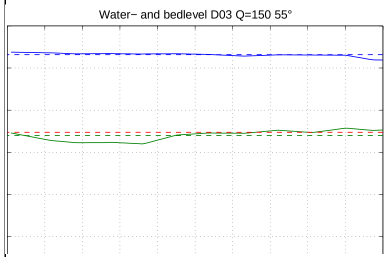
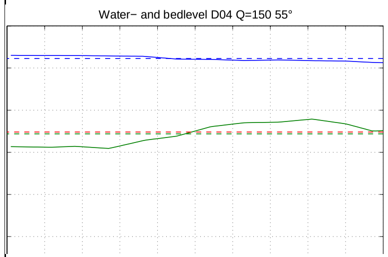
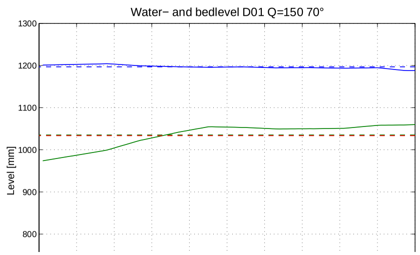
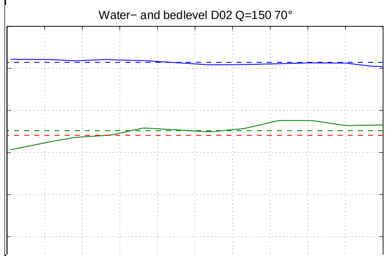
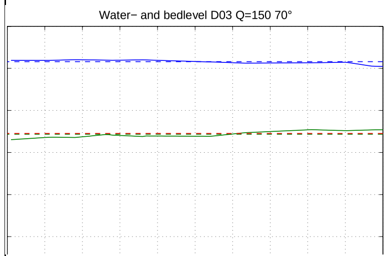
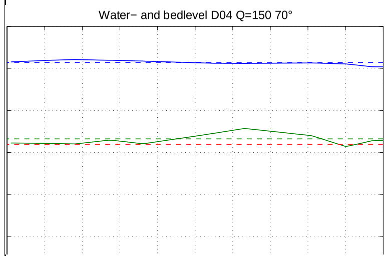
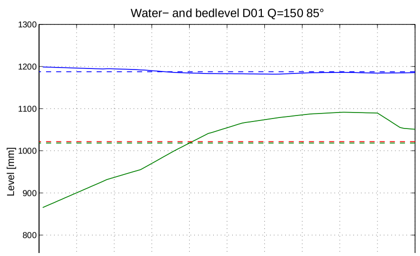
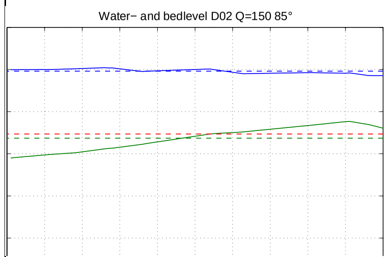
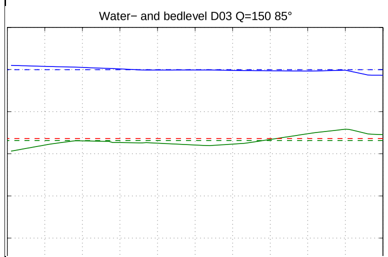
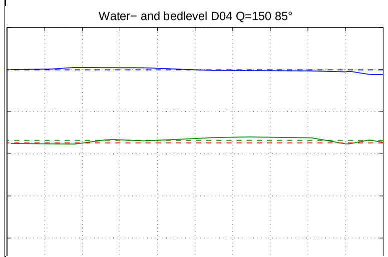
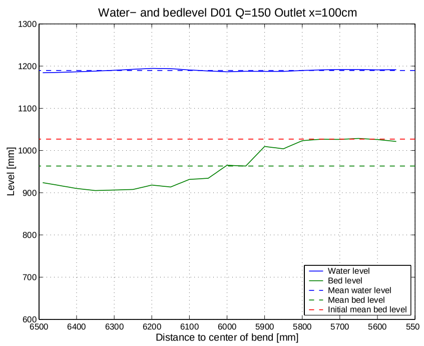
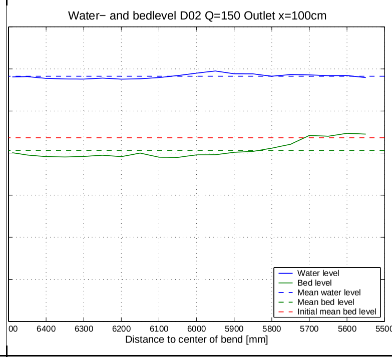
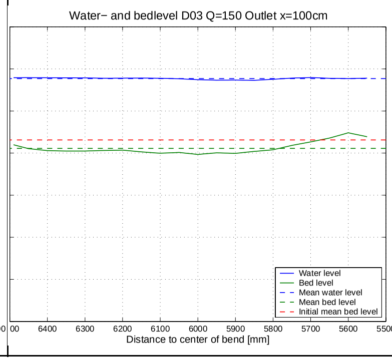
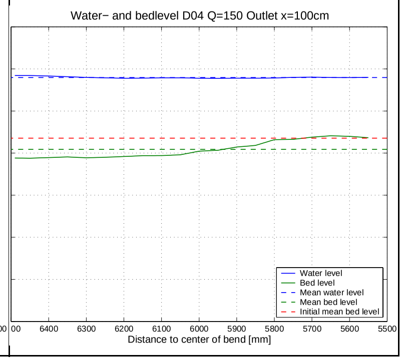
Pos.	WITHOUT MR	MR-SPACING 4°	MR-SPACING 2°	MR-SPACING 1°
55°				
70°				
85°				
1m				

Table 7.1: Cross sections, $S_0 = 0.35\%$, $Q=150$ l/s, mr-depth = 20 mm

7.2 Cross sections at S_0=0.35%, Q=180 l/s, e_d=20mm

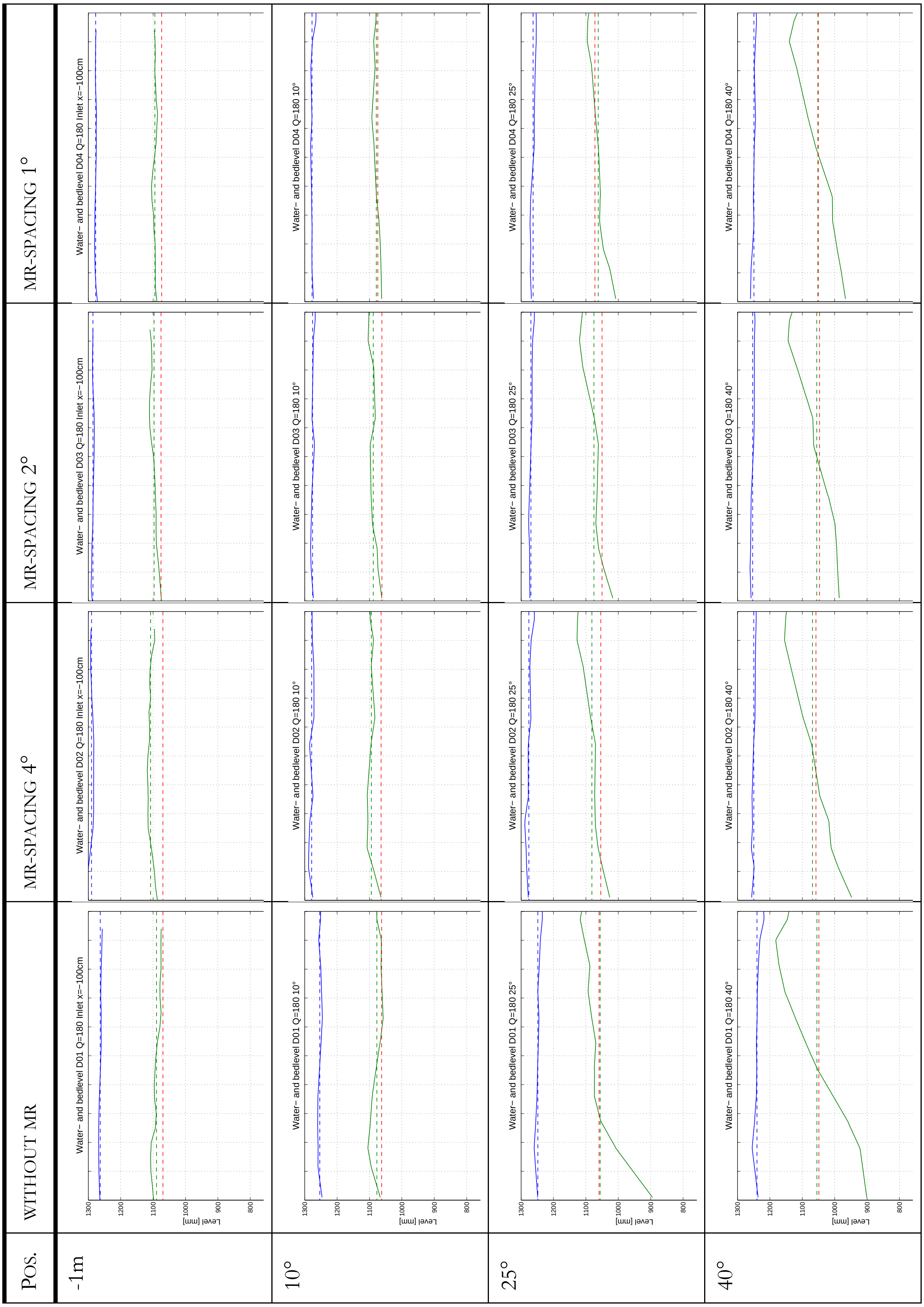


Table 7.2: Cross sections, S_0 = 0.35%, Q=180 l/s, mr-depth = 20 mm

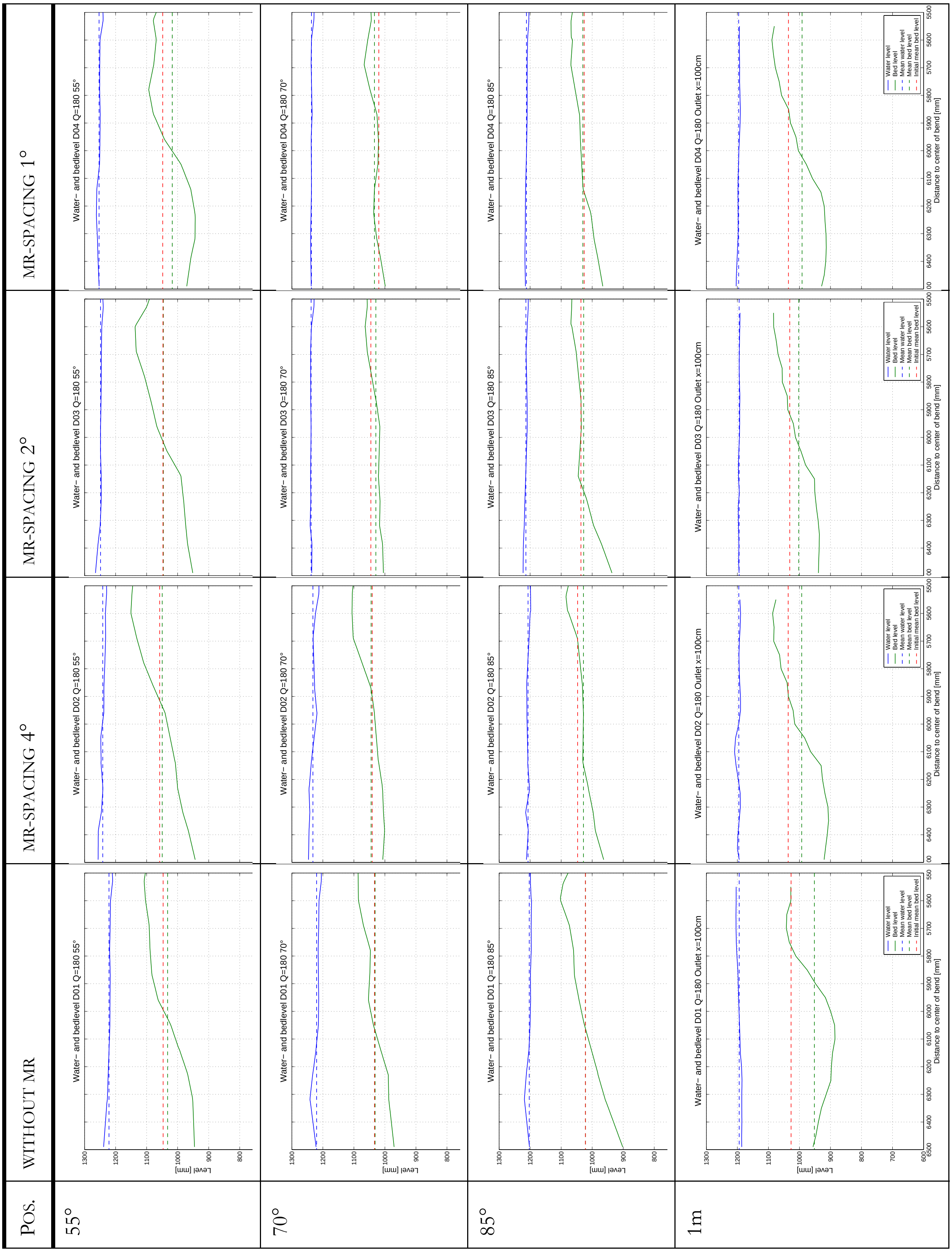


Table 7.2: Cross sections, $S_0 = 0.35\%$, $Q=180$ l/s, mr-depth = 20 mm

7.3 Cross sections at S_0=0.35%, Q=210 l/s, e_d=20mm

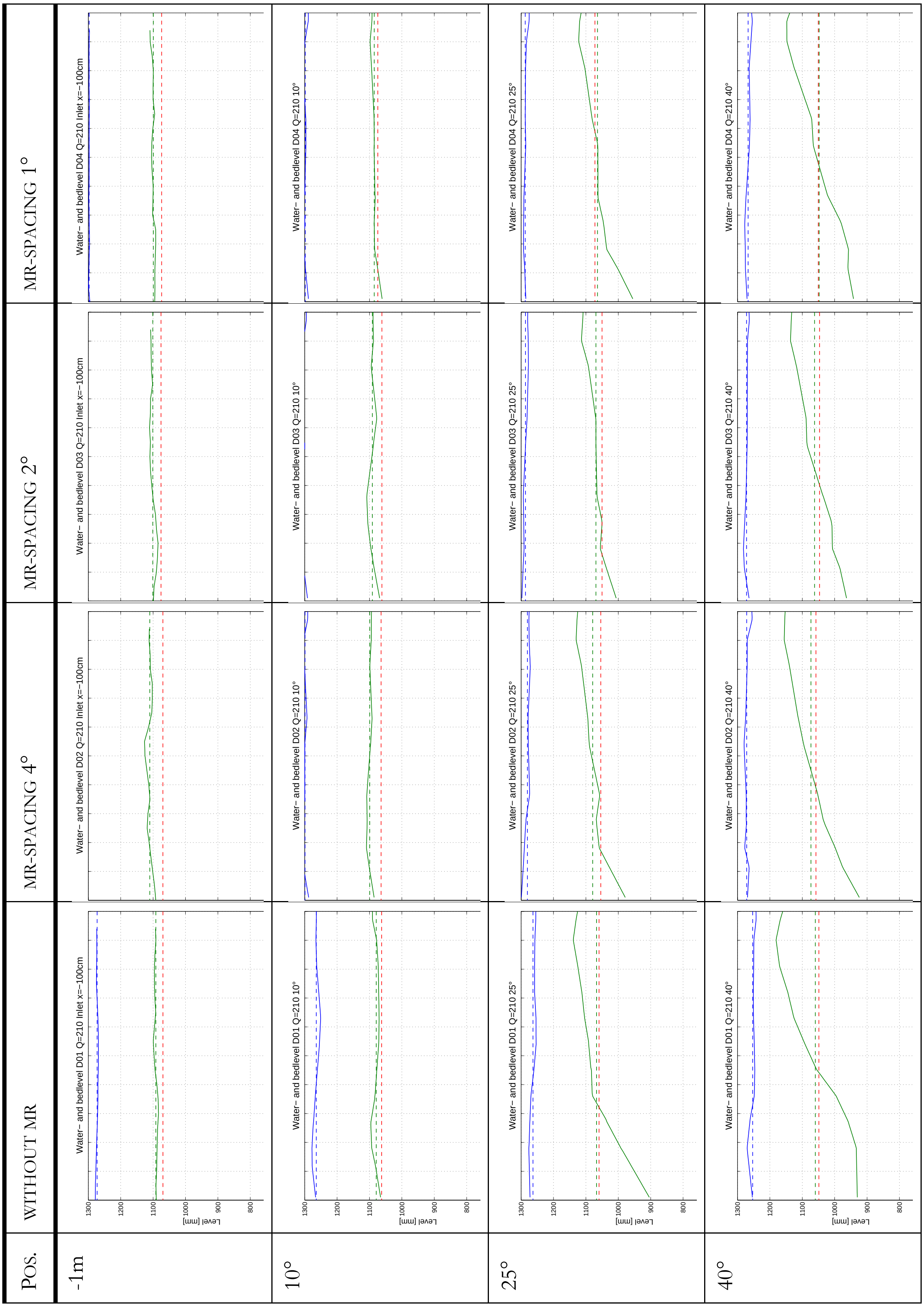


Table 7.3: Cross sections, S_0 = 0.35%, Q=210 l/s, mr-depth = 20 mm

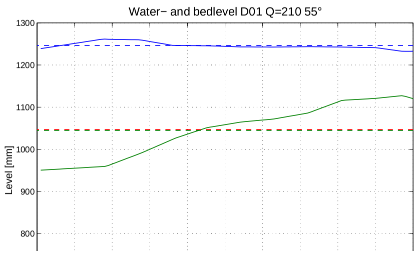
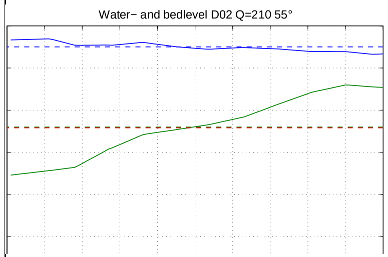
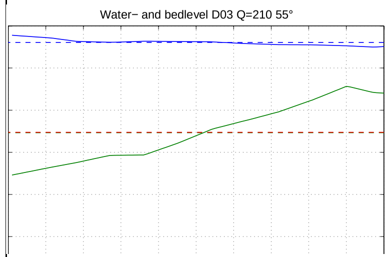
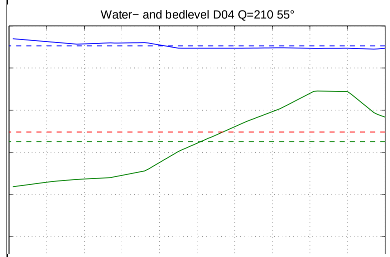
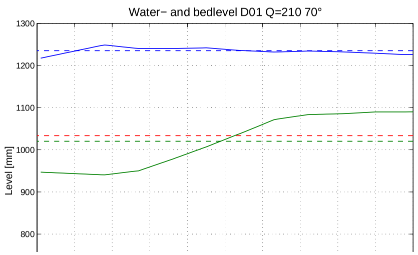
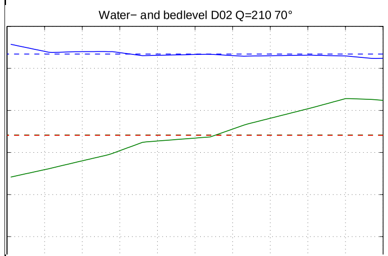
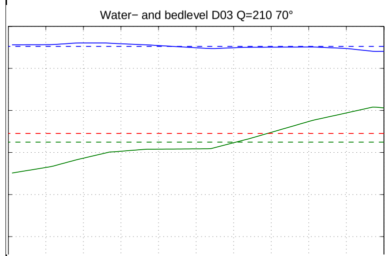
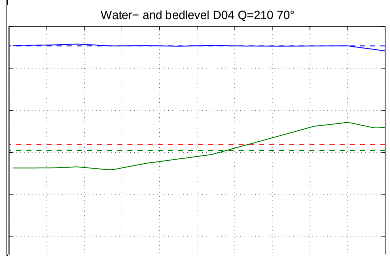
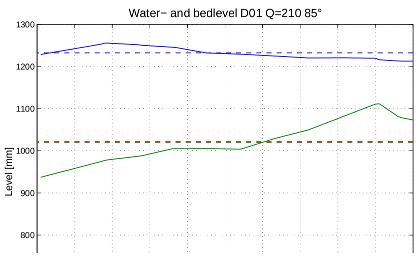
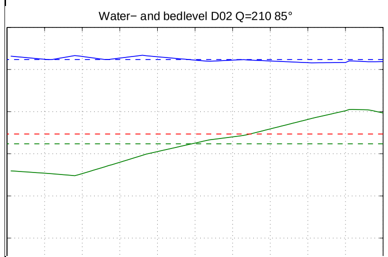
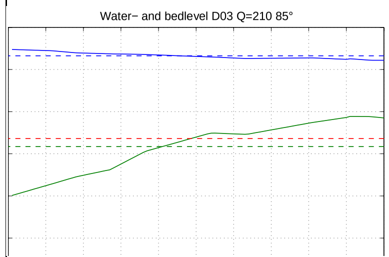
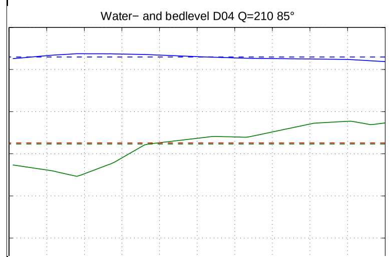
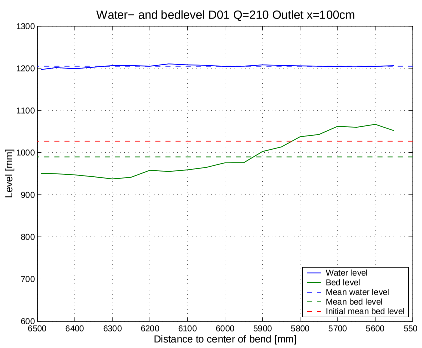
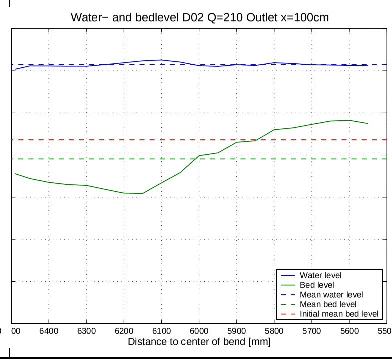
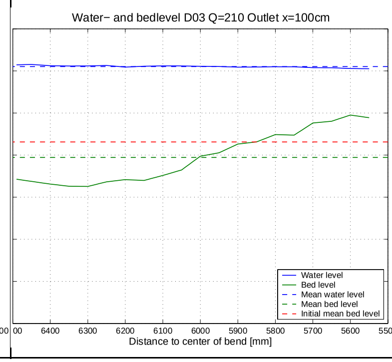
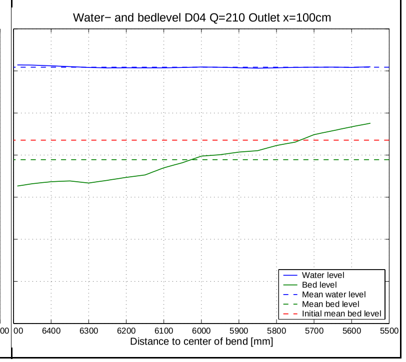
Pos.	Without MR	MR-spacing 4°	MR-spacing 2°	MR-spacing 1°
55°				
70°				
85°				
1m				

Table 7.3: Cross sections, $S_0 = 0.35\%$, Q=210 l/s, mr-depth = 20 mm

7.4 Cross sections at S_0=0.50%, Q=150 l/s, e_d=20mm

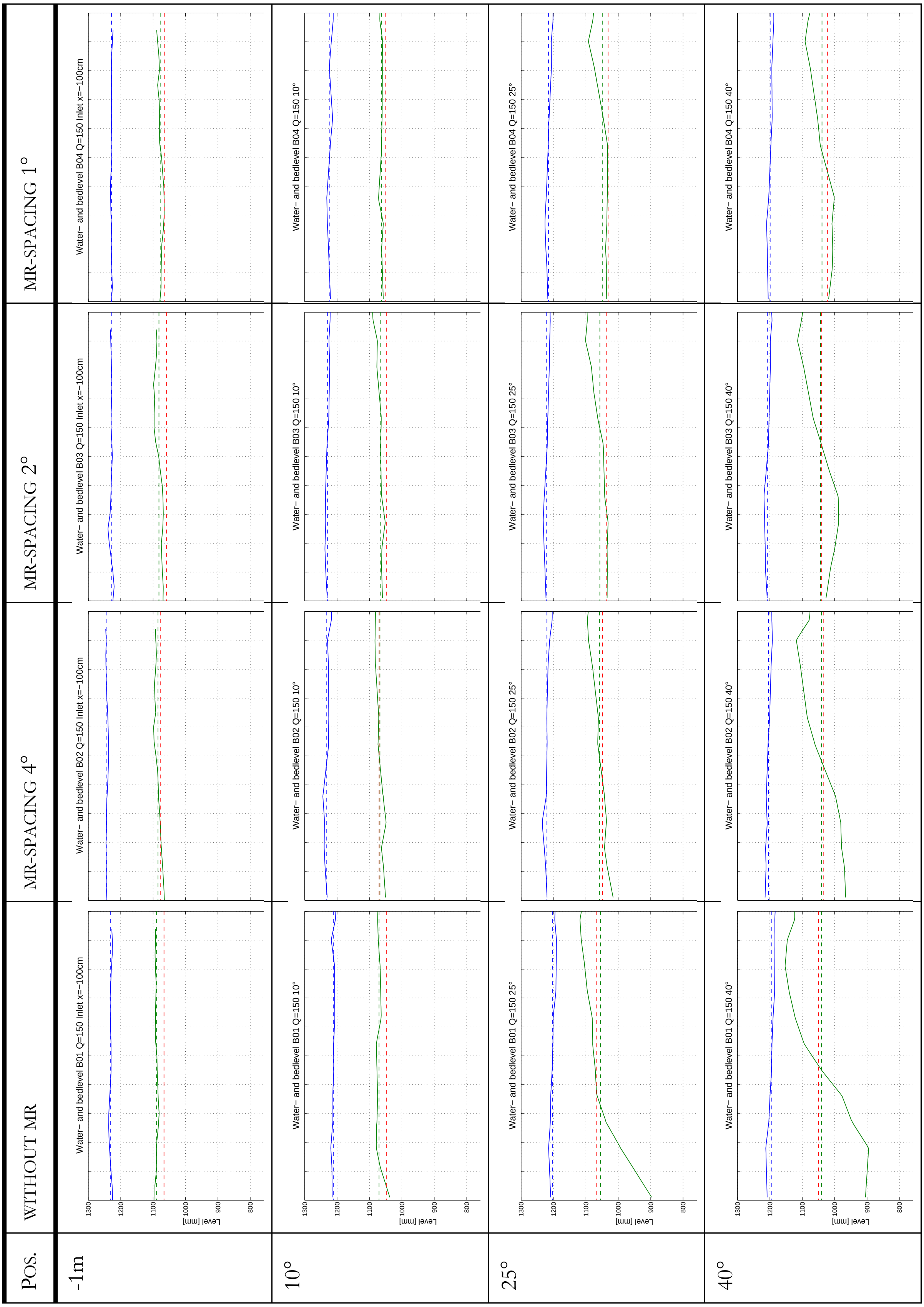


Table 7.4: Cross sections, S_0 = 0.50%, Q=150 l/s, mr-depth = 20 mm

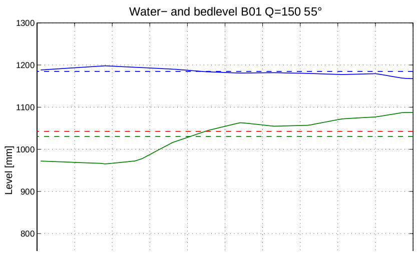
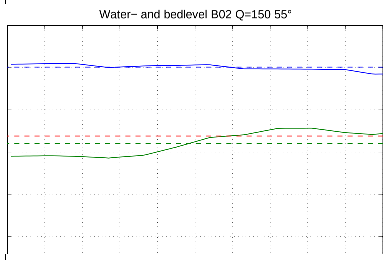
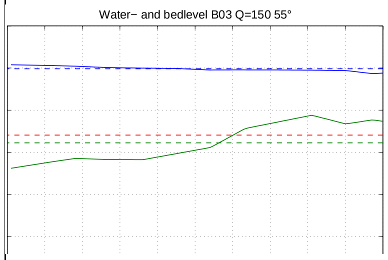
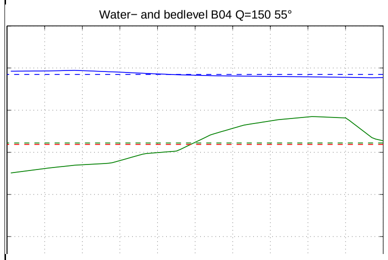
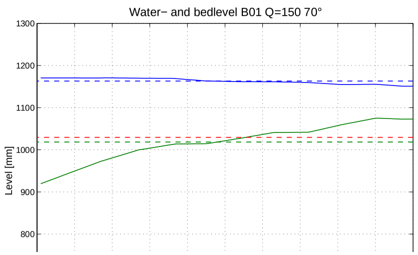
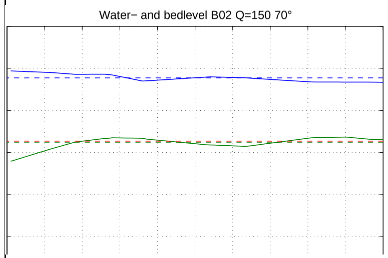
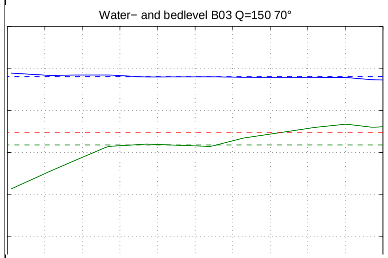
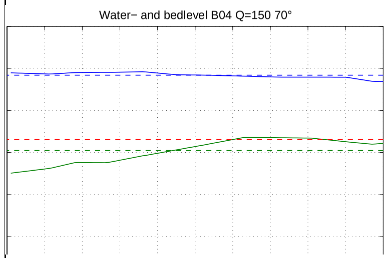
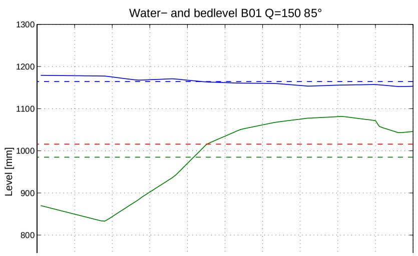
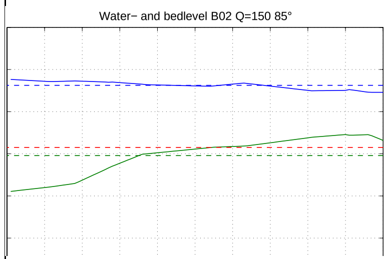
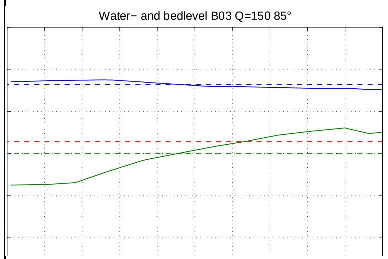
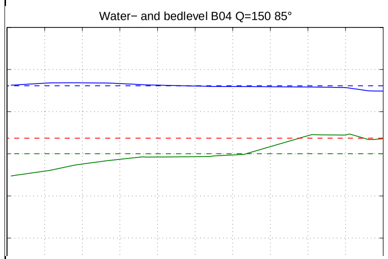
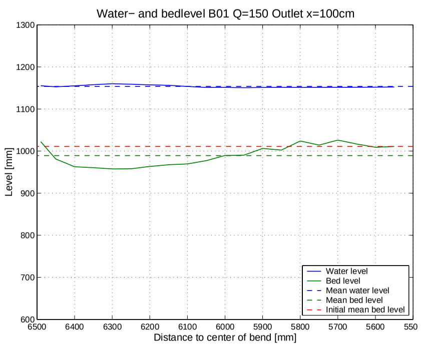
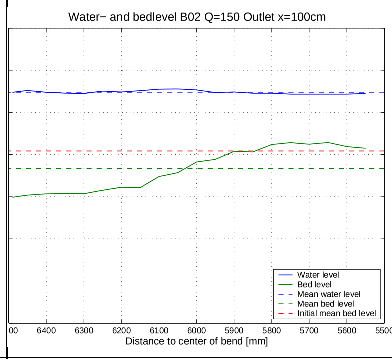
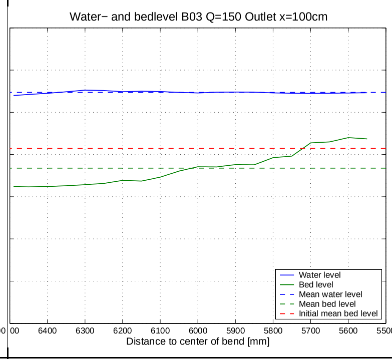
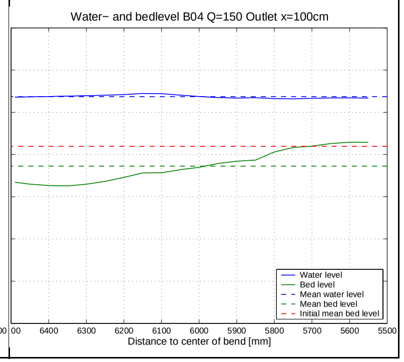
Pos.	WITHOUT MR	MR-SPACING 4°	MR-SPACING 2°	MR-SPACING 1°
55°				
70°				
85°				
1m				

Table 7.4: *Cross sections, $S_0 = 0.50\%$, Q=150 l/s, mr-depth = 20 mm*

7.5 Cross sections at S_0=0.50%, Q=180 l/s, e_d=20mm

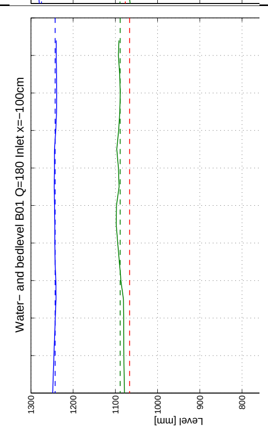
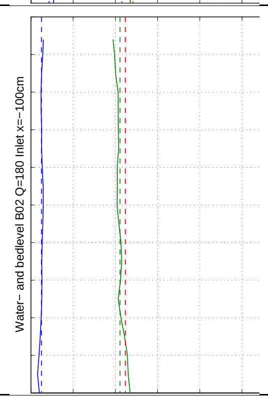
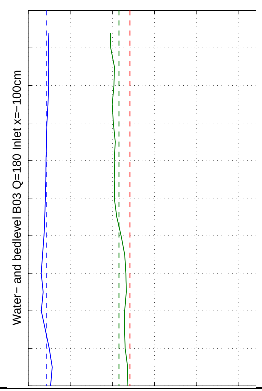
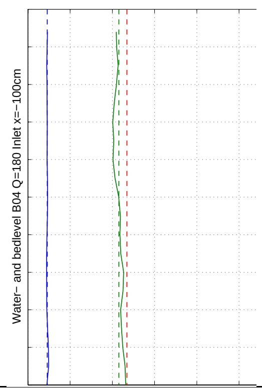
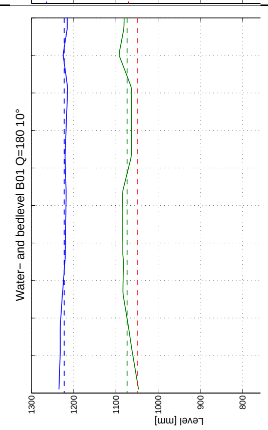
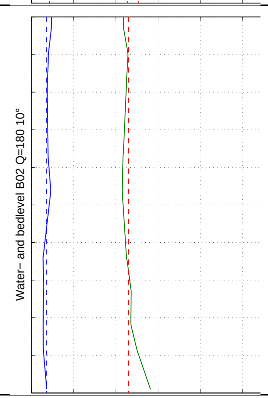
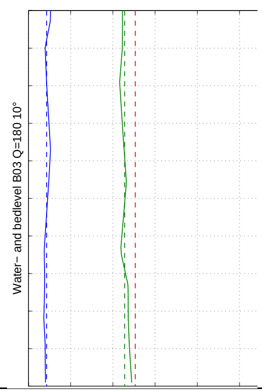
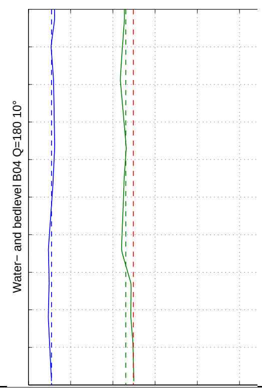
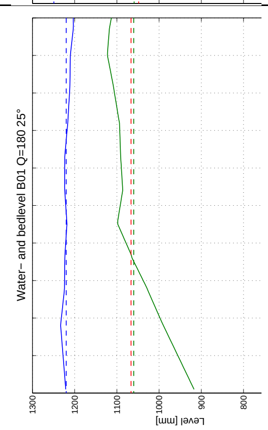
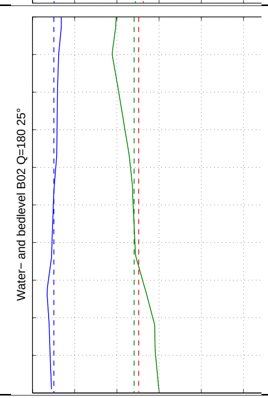
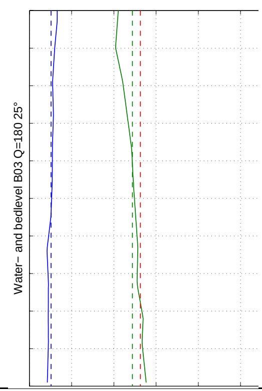
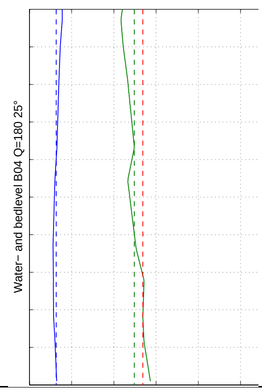
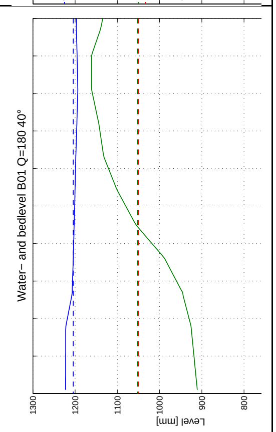
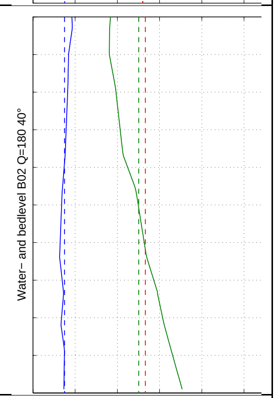
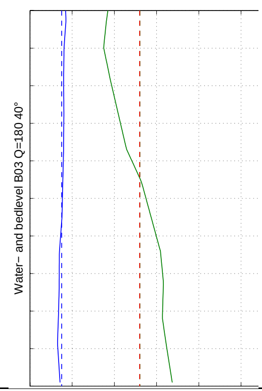
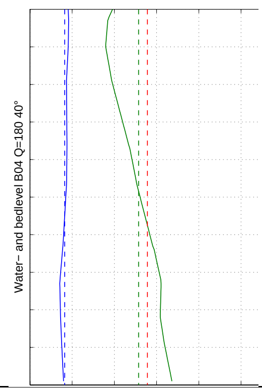
Pos.	WITHOUT MR	MR-SPACING 4°	MR-SPACING 2°	MR-SPACING 1°
-1m				
10°				
25°				
40°				

Table 7.5: Cross sections, S_0 = 0.50%, Q=180 l/s, mr-depth = 20 mm

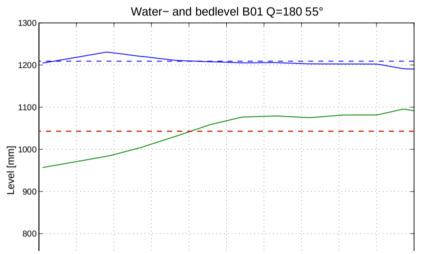
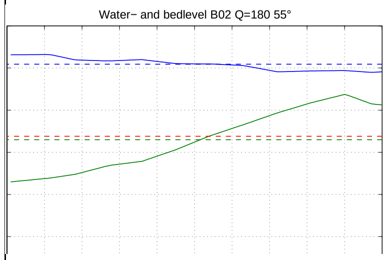
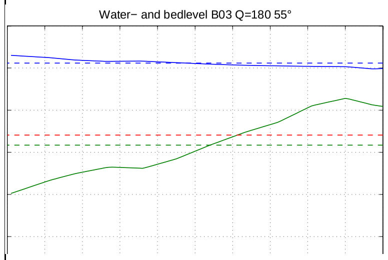
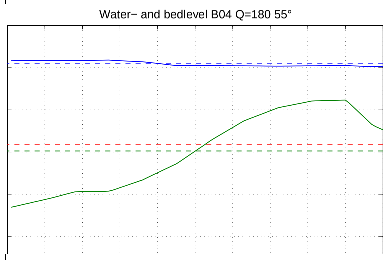
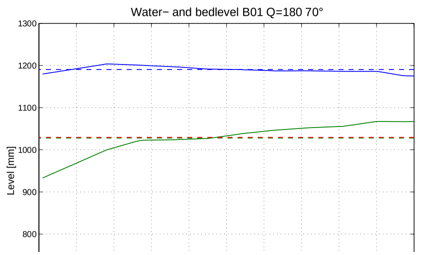
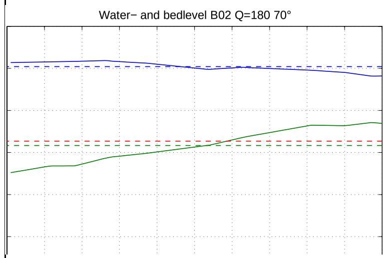
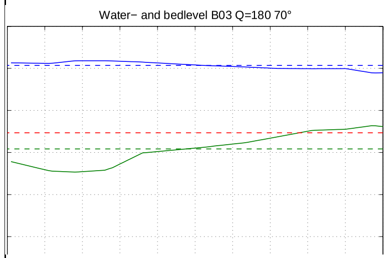
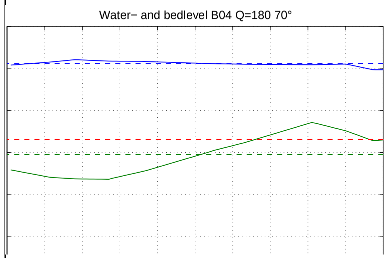
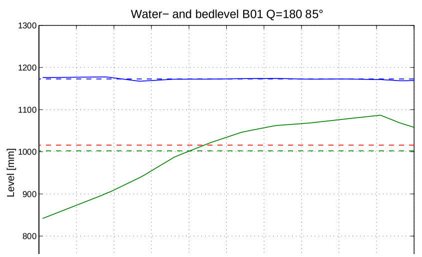
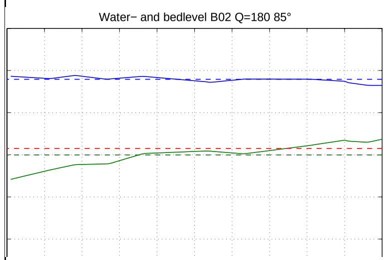
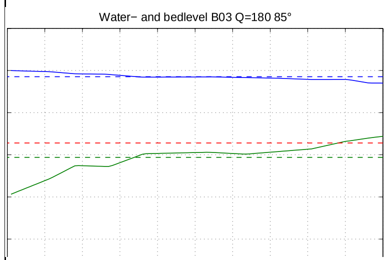
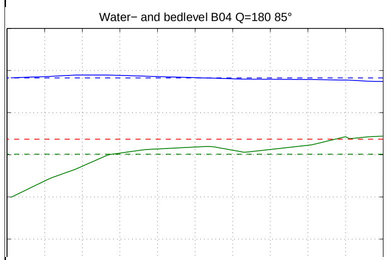
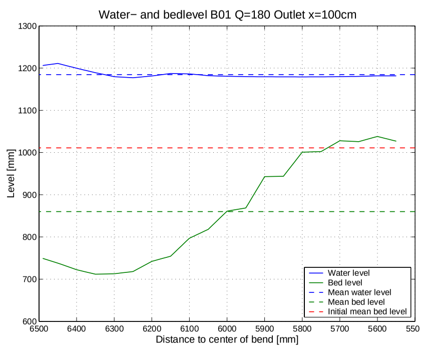
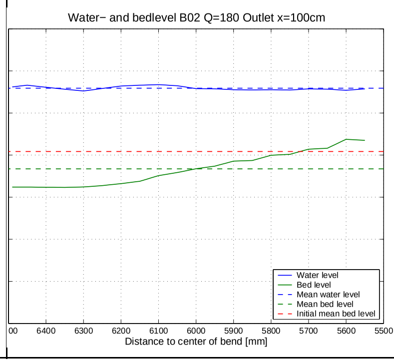
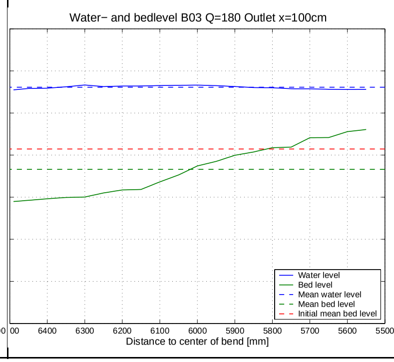
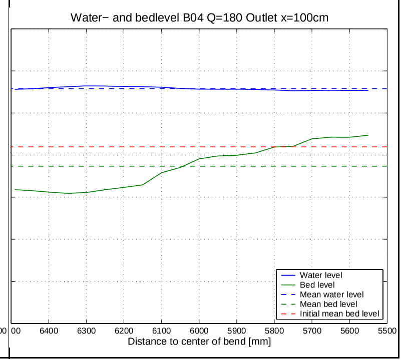
POS.	WITHOUT MR	MR-SPACING 4°	MR-SPACING 2°	MR-SPACING 1°
55°				
70°				
85°				
1m				

Table 7.5: Cross sections, $S_0 = 0.50\%$, Q=180 l/s, mr-depth = 20 mm

7.6 Cross sections at S_0=0.50%, Q=210 l/s, e_d=20mm

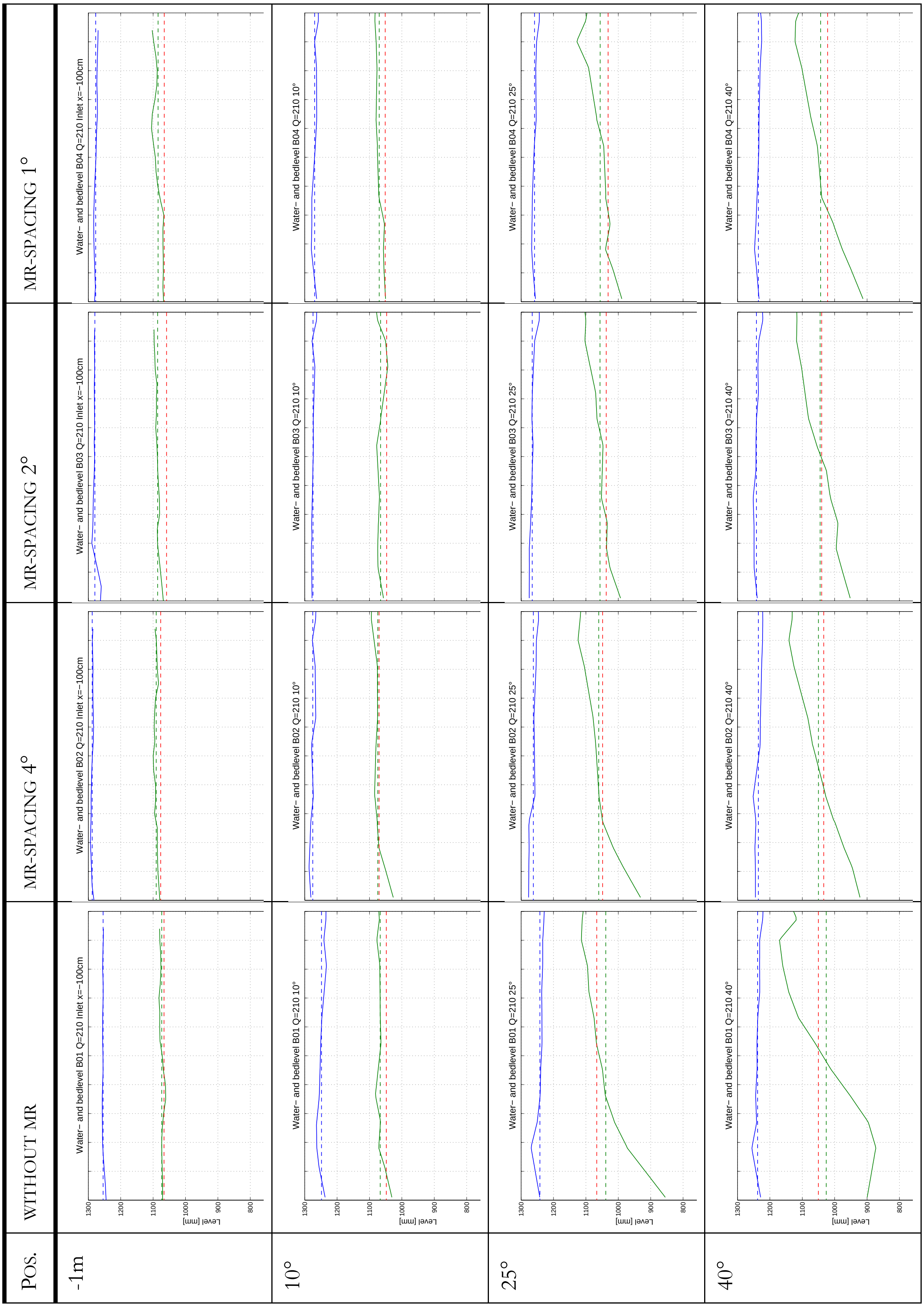


Table 7.6: Cross sections, S_0 = 0.50%, Q=210 l/s, mr-depth = 20 mm

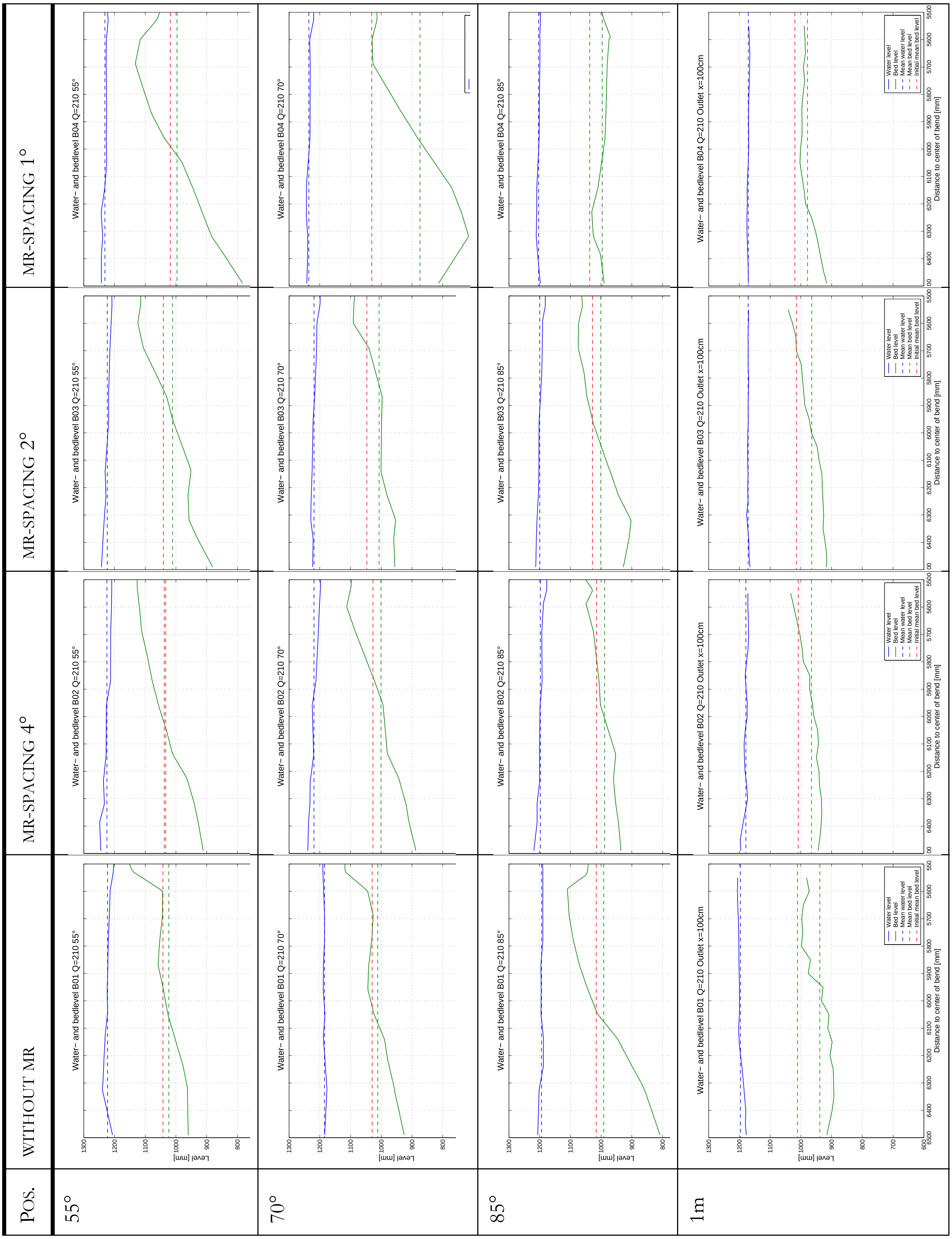


Table 7.6: Cross sections, $S_0 = 0.50\%$, $Q=210\ l/s$, mr-depth = 20 mm

7.7 Cross sections at S_0=0.70%, Q=150 l/s, e_d=20mm

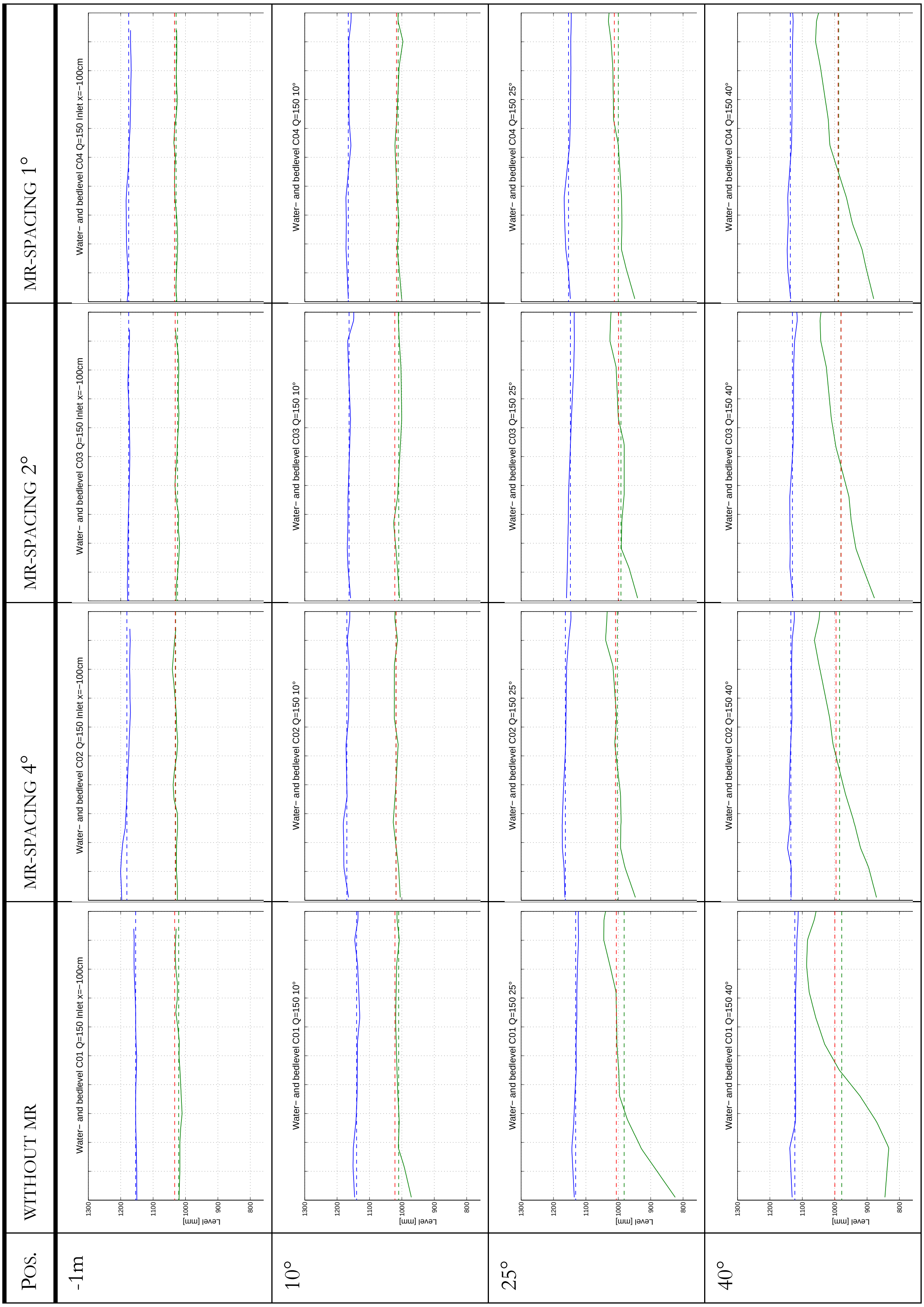


Table 7.7: Cross sections, S_0 = 0.70%, Q=150 l/s, mr-depth = 20 mm

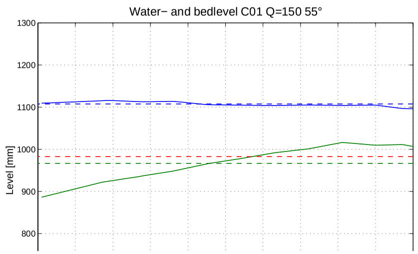
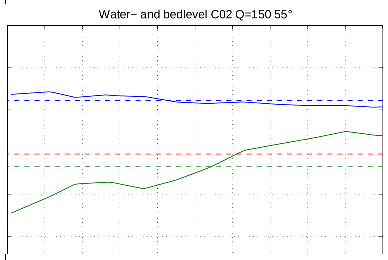
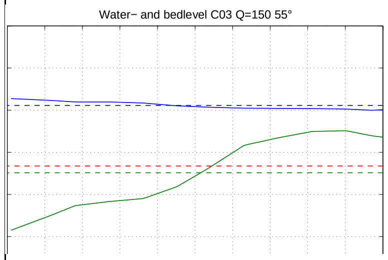
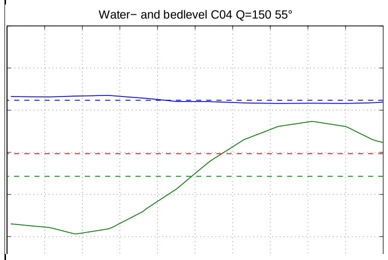
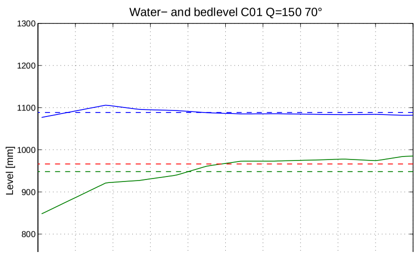
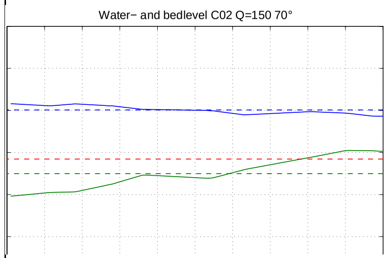
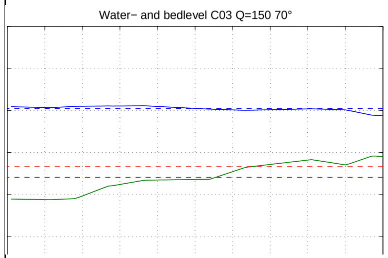
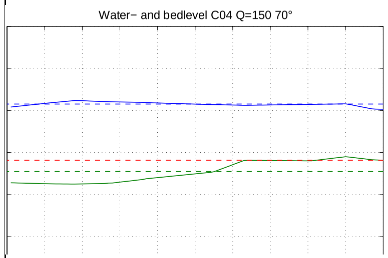
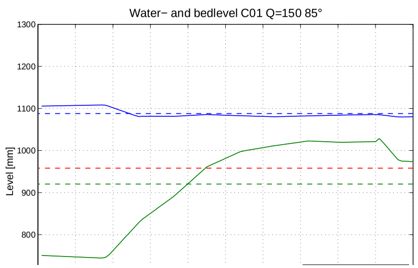
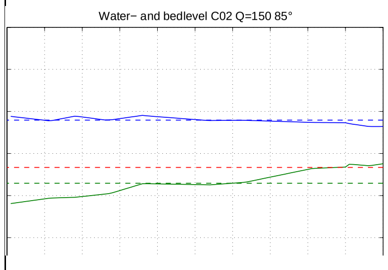
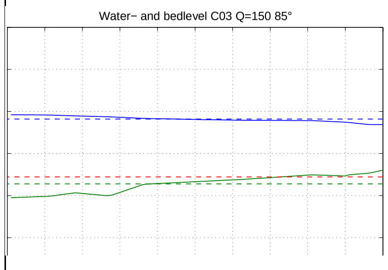
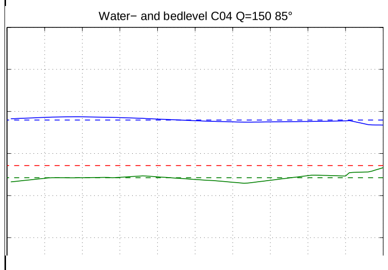
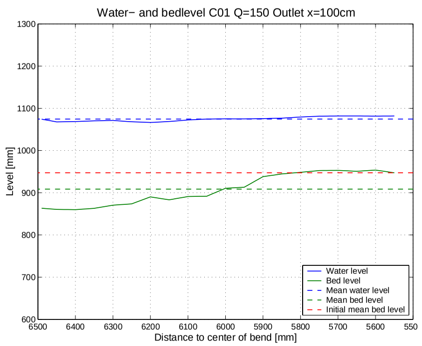
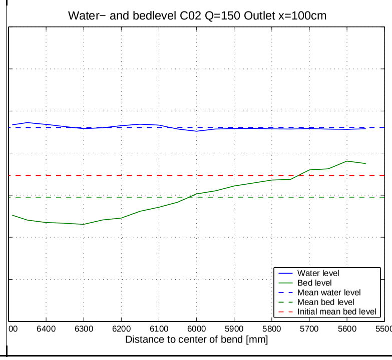
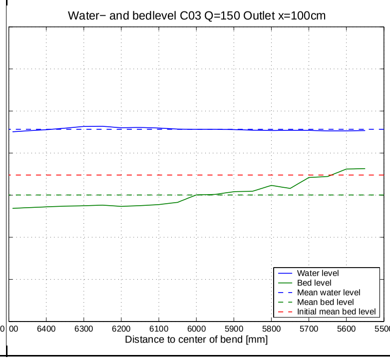
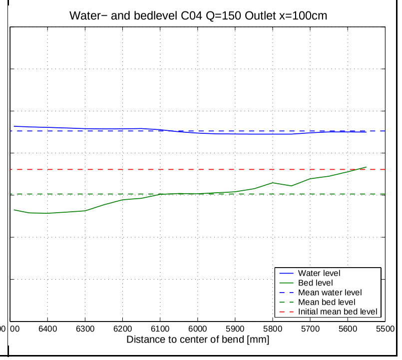
Pos.	WITHOUT MR	MR-SPACING 4°	MR-SPACING 2°	MR-SPACING 1°
55°				
70°				
85°				
1m				

Table 7.7: Cross sections, $S_0 = 0.70\%$, Q=150 l/s, mr-depth = 20 mm

7.8 Cross sections at S_0=0.70%, Q=180 l/s, e_d=20mm

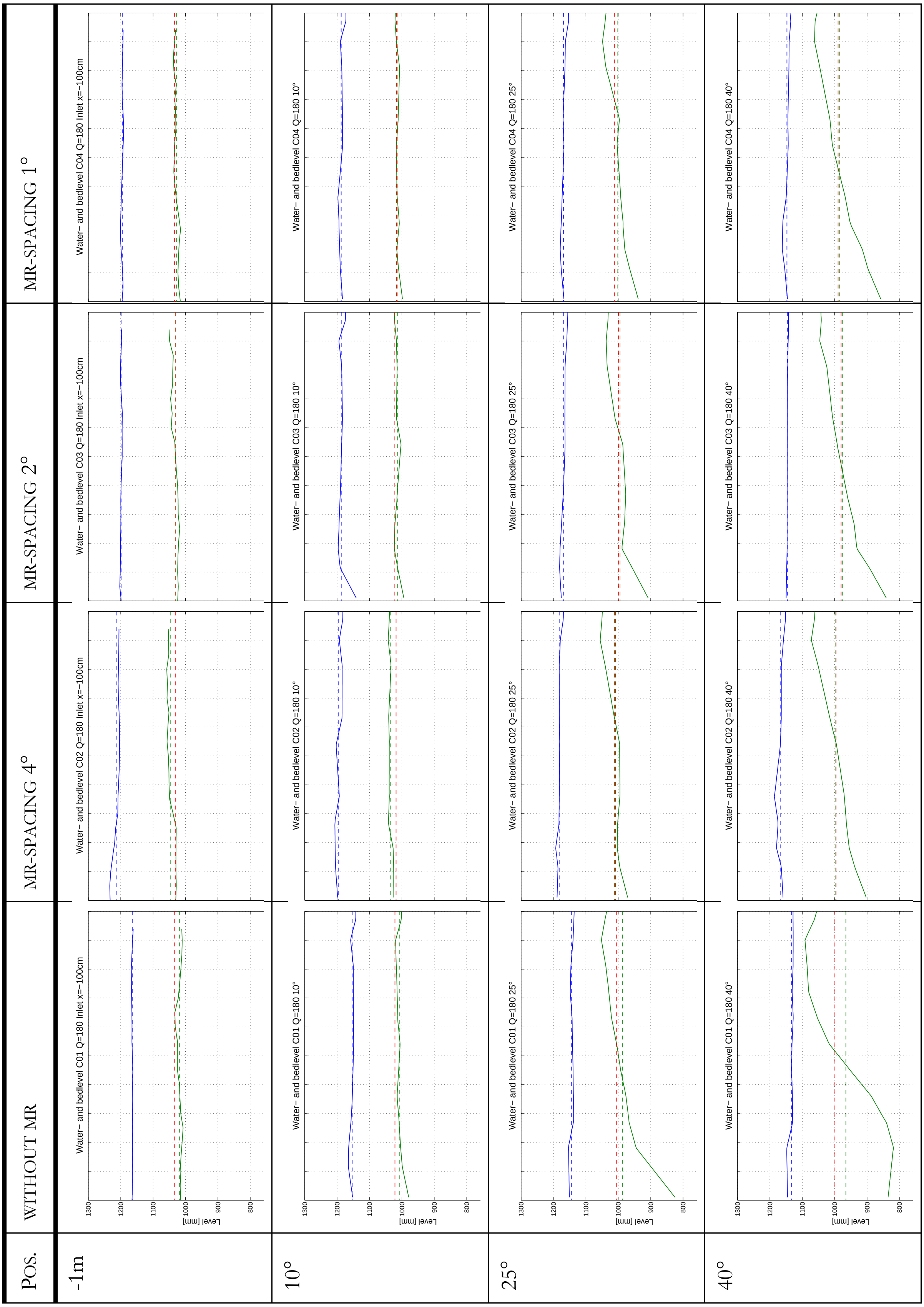


Table 7.8: Cross sections, S_0 = 0.70%, Q=180 l/s, mr-depth = 20 mm

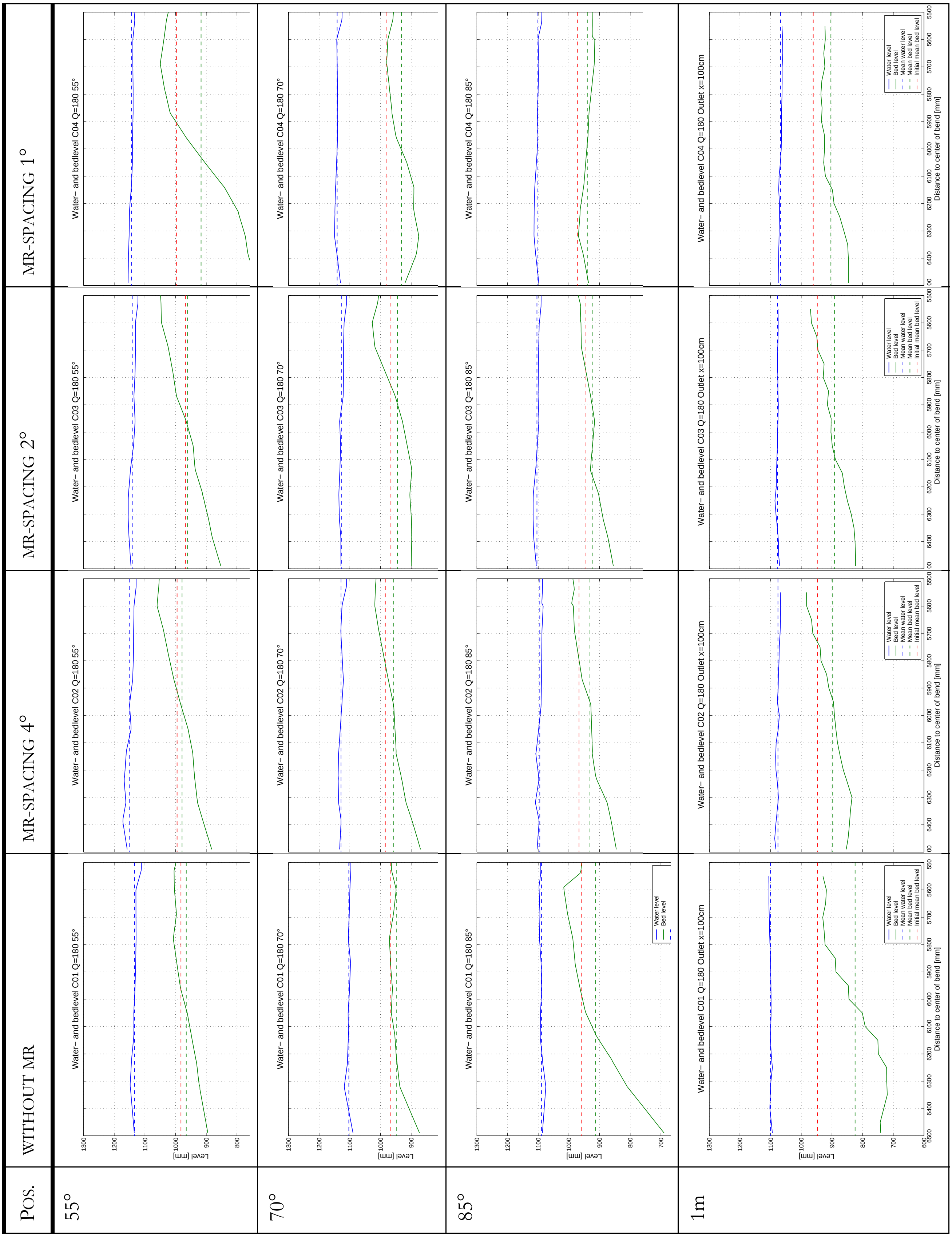


Table 7.8: Cross sections, $S_0 = 0.70\%$, $Q=180$ l/s, mr-depth = 20 mm

7.9 Cross sections at S_0=0.70%, Q=210 l/s, e_d=20mm

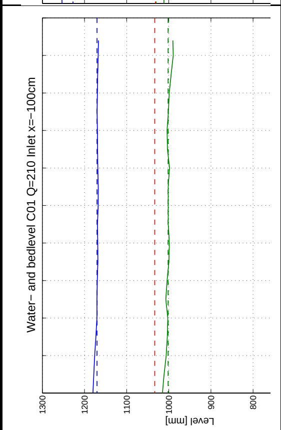
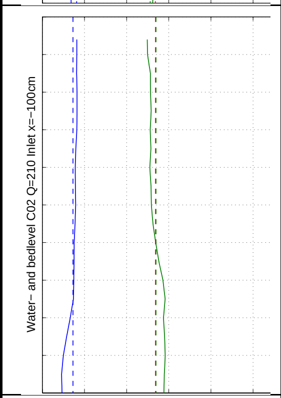
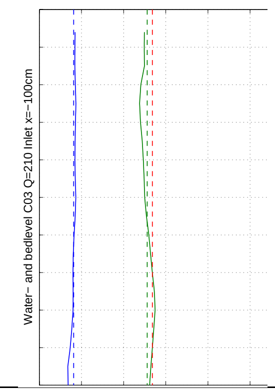
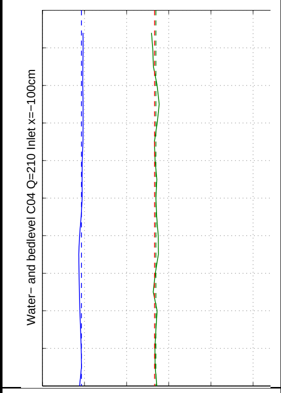
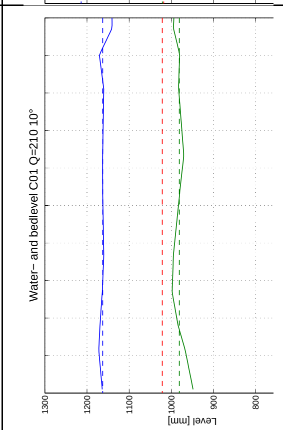
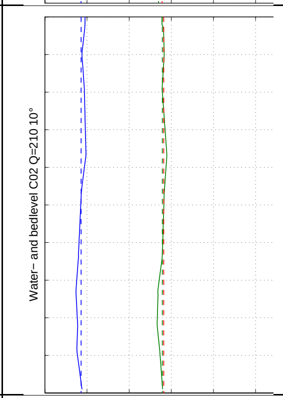
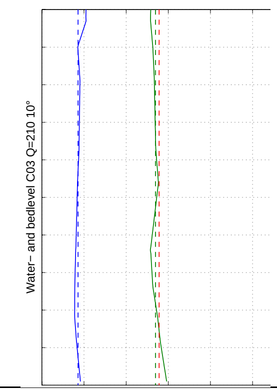
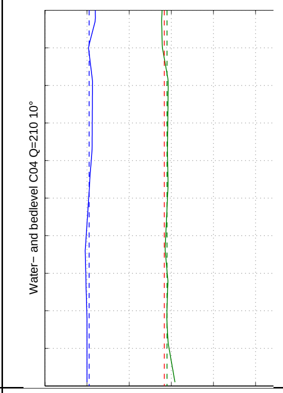
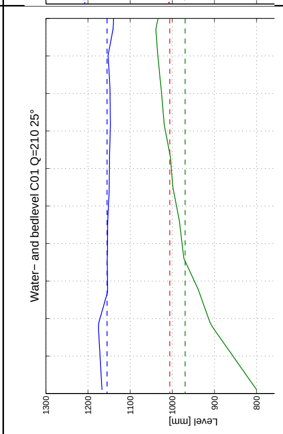
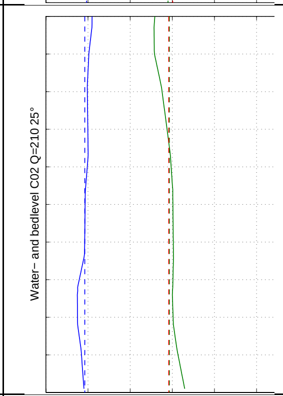
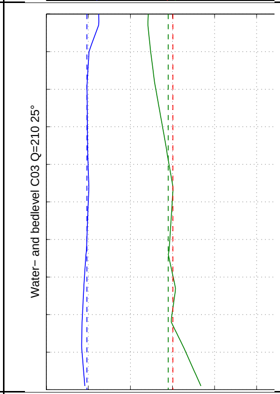
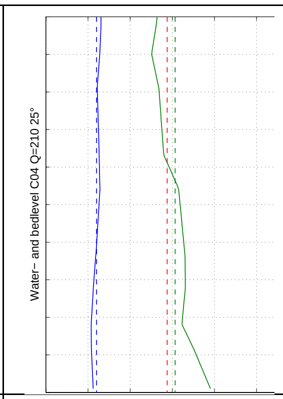
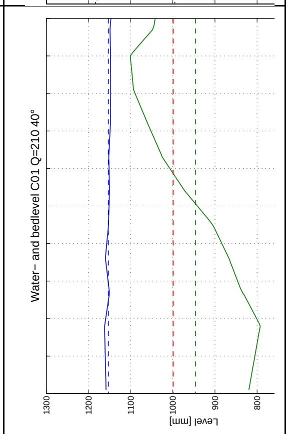
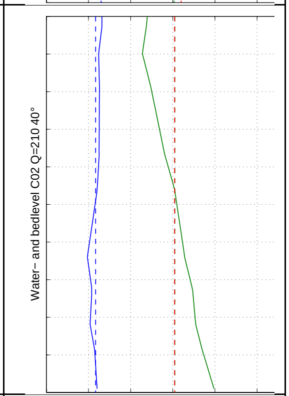
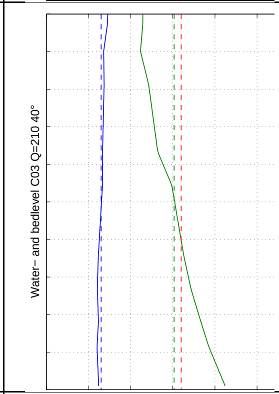
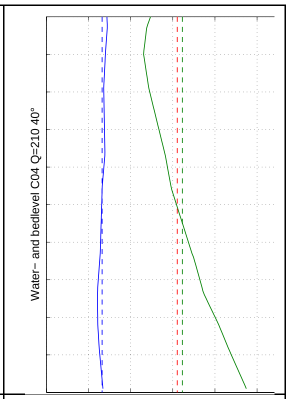
Pos.	WITHOUT MR	MR-SPACING 4°	MR-SPACING 2°	MR-SPACING 1°
-1m				
10°				
25°				
40°				

Table 7.9: Cross sections, S_0 = 0.70%, Q=210 l/s, mr-depth = 20 mm

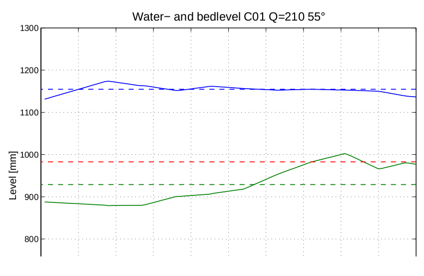
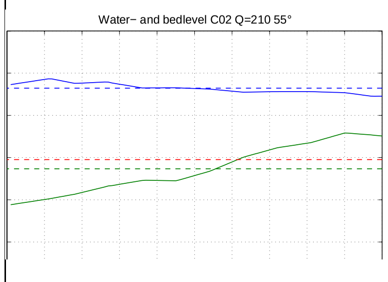
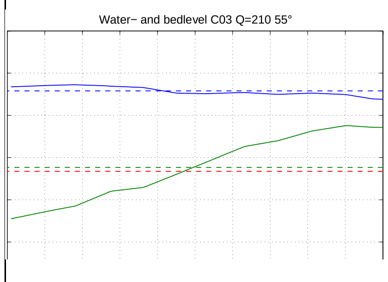
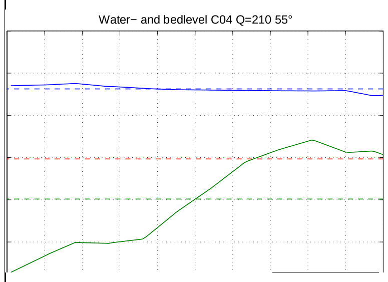
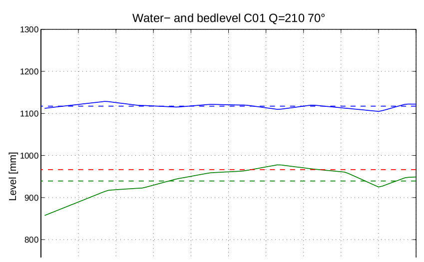
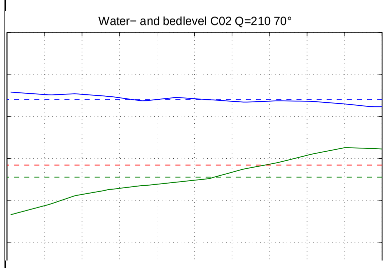
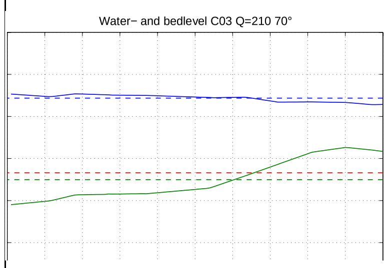
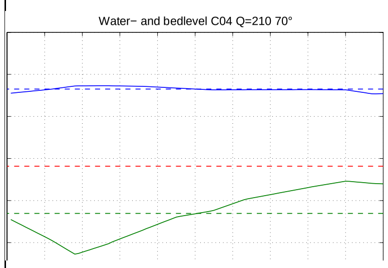
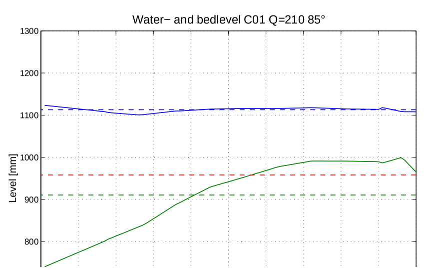
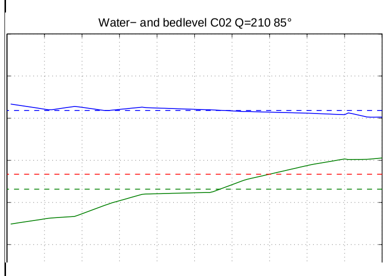
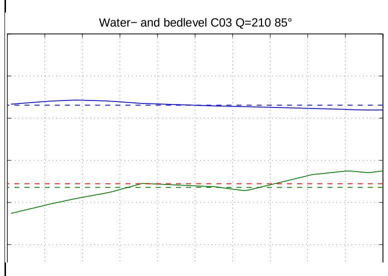
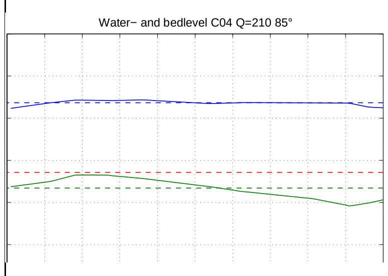
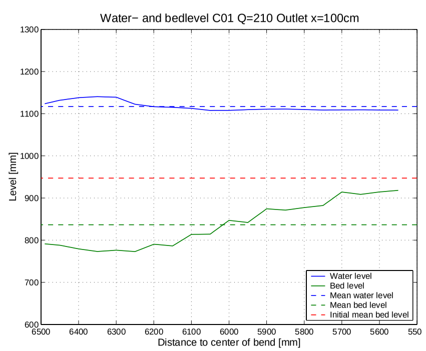
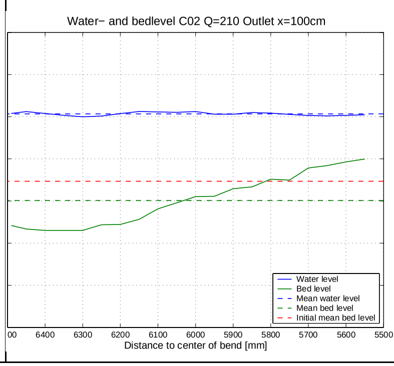
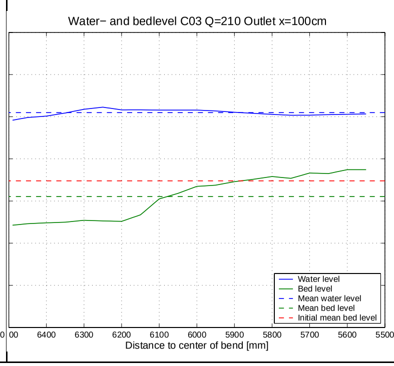
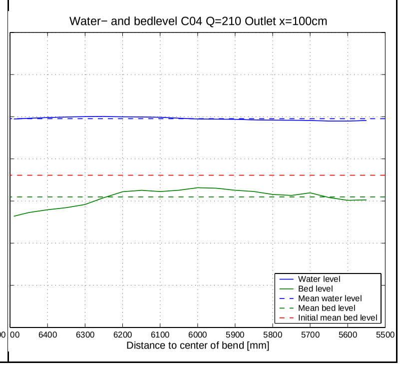
Pos.	WITHOUT MR	MR-SPACING 4°	MR-SPACING 2°	MR-SPACING 1°
55°				
70°				
85°				
1m				

Table 7.9: Cross sections, S_0 = 0.70%, Q=210 l/s, mr-depth = 20 mm

7.10 Cross sections at S_0=0.50%, Q=150 l/s, e_d=40mm

Pos.	WITHOUT MR	MR-SPACING 8°	MR-SPACING 4°	MR-SPACING 2°
-1m				
10°				
25°				
40°				

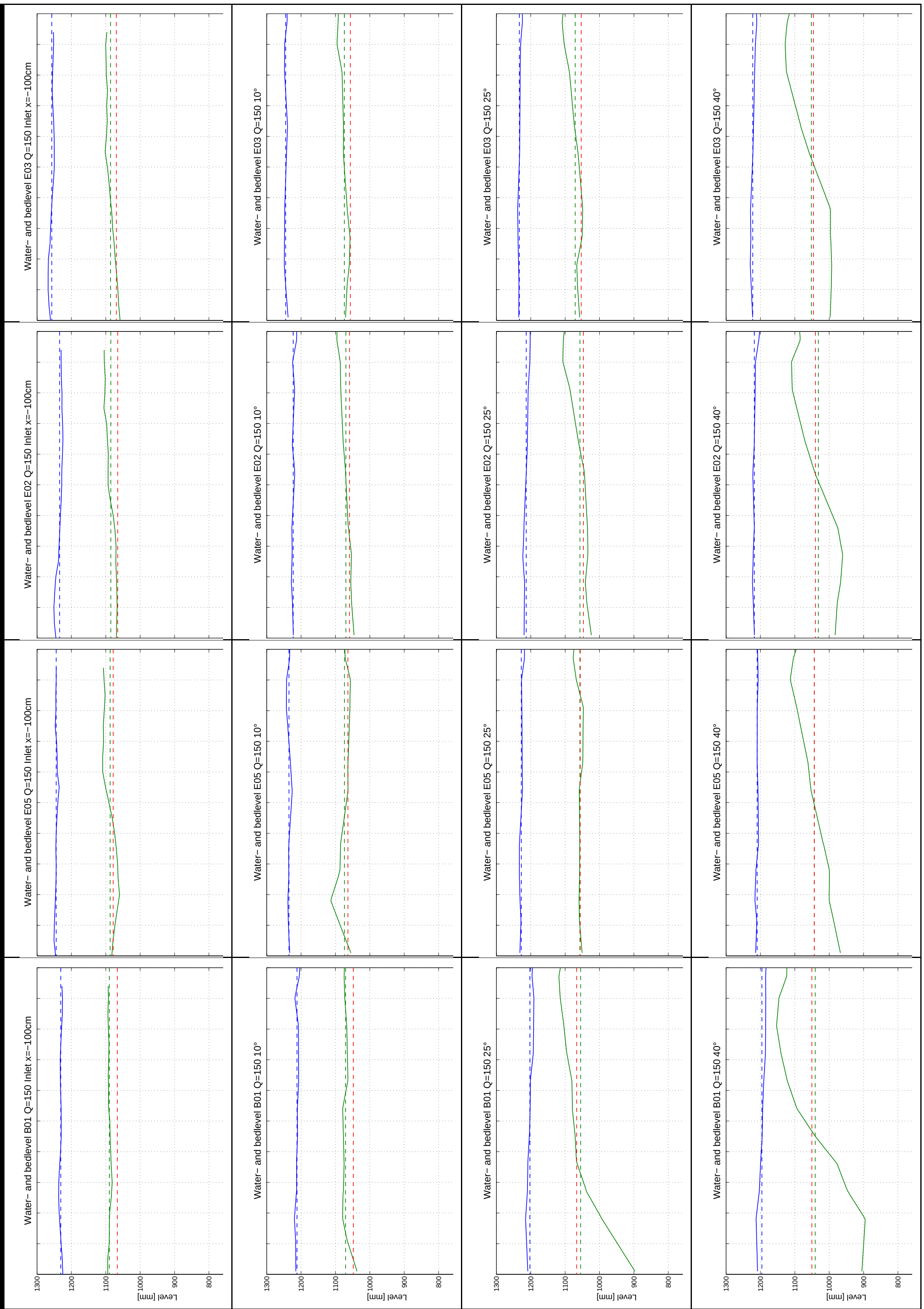


Table 7.10: Cross sections, S_0 = 0.50%, Q=150 l/s, mr-depth = 40 mm

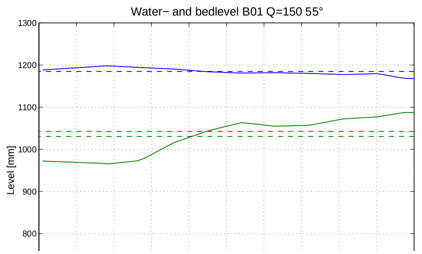
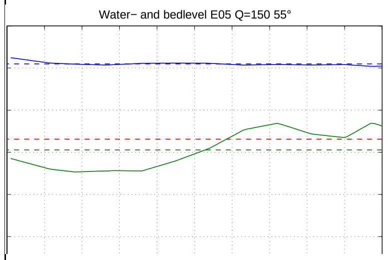
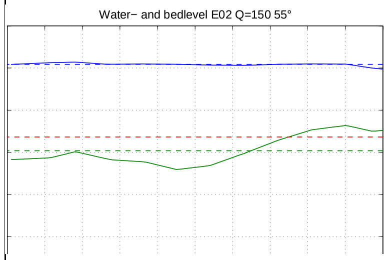
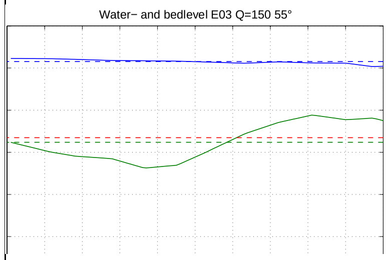
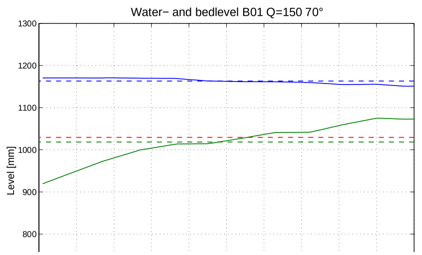
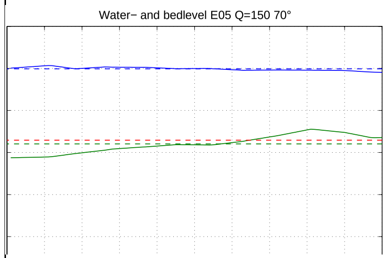
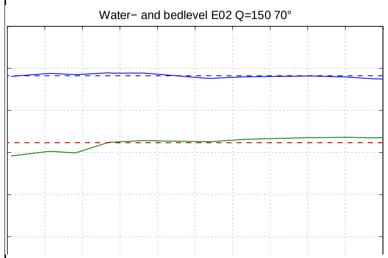
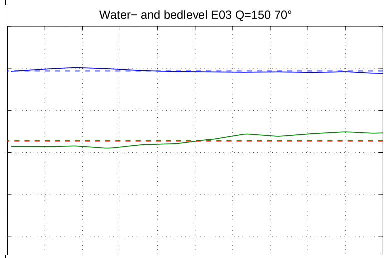
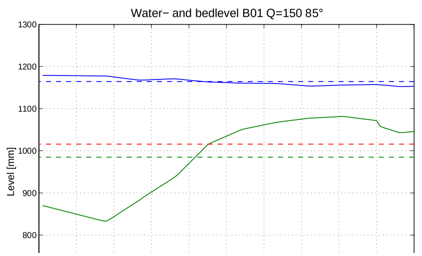
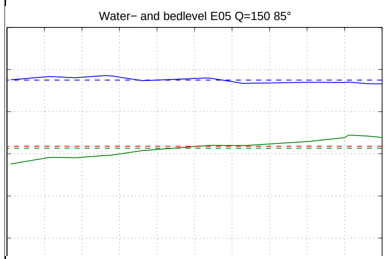
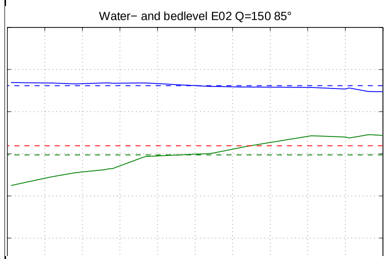
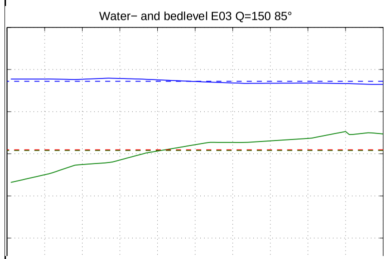
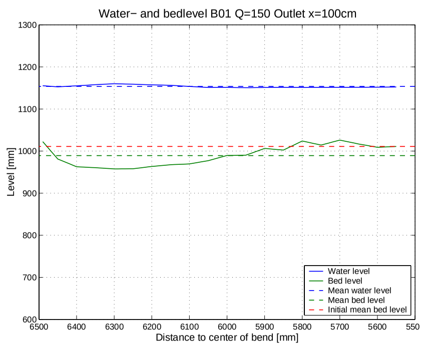
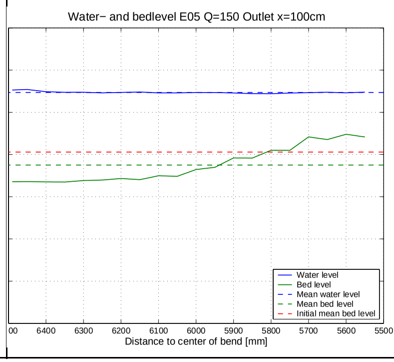
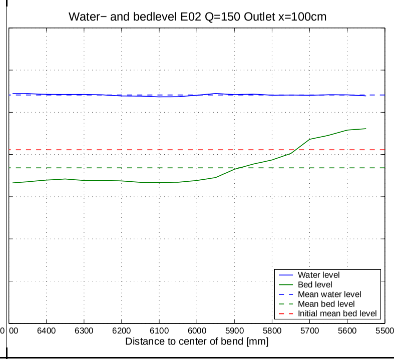
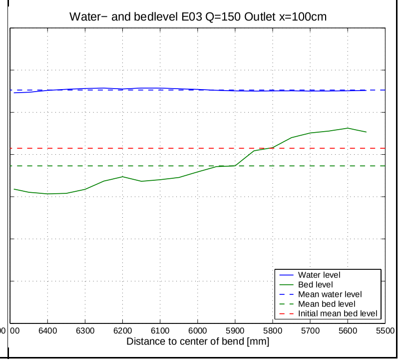
Pos.	WITHOUT MR	MR-SPACING 8°	MR-SPACING 4°	MR-SPACING 2°
55°				
70°				
85°				
1m				

Table 7.10: Cross sections, $S_0 = 0.50\%$, Q=150 l/s, mr-depth = 40 mm

7.11 Cross sections at S_0=0.50%, Q=180 l/s, e_d=40mm

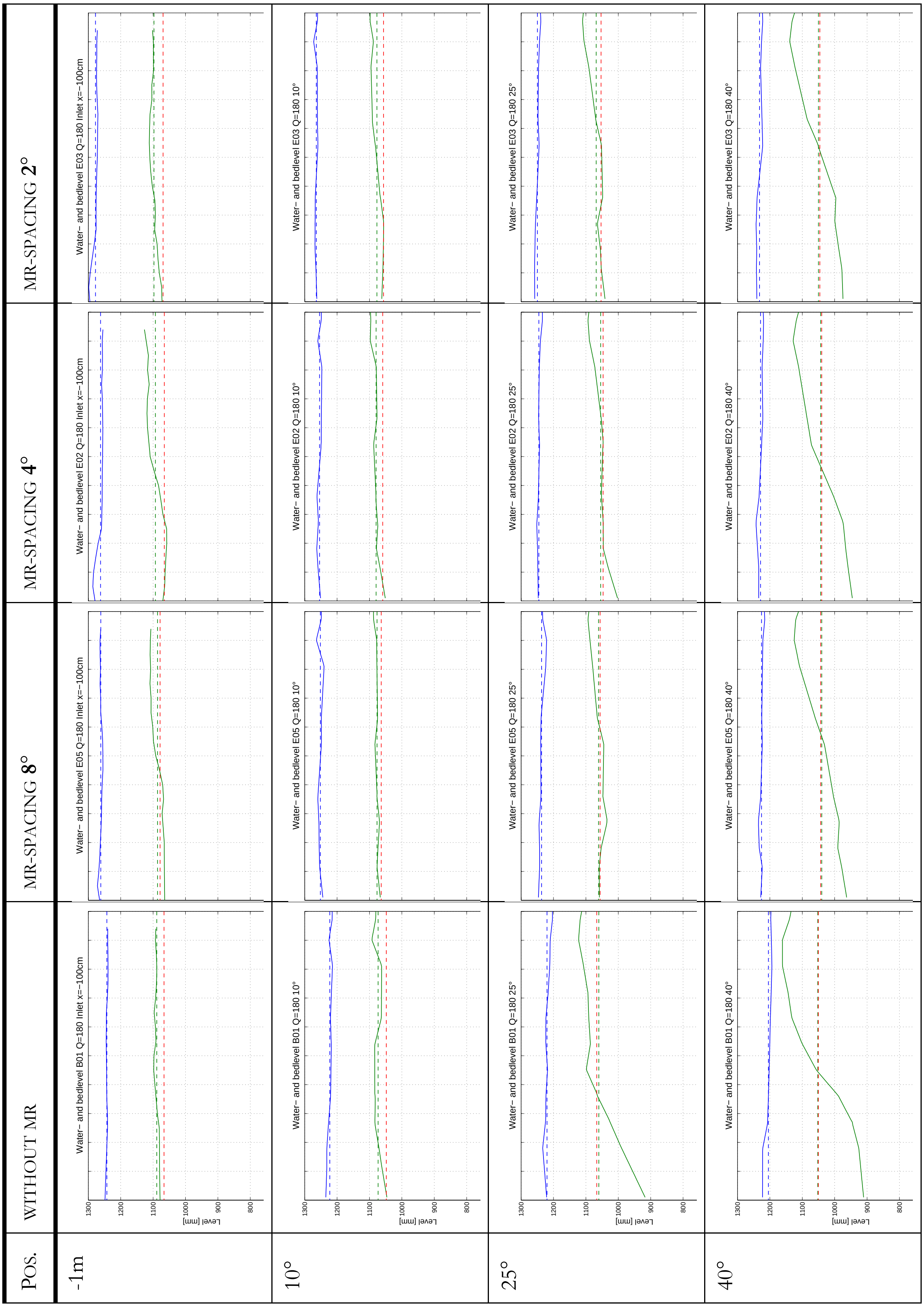


Table 7.11: Cross sections, S_0 = 0.50%, Q=180 l/s, mr-depth = 40 mm

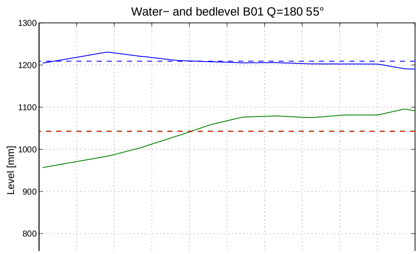
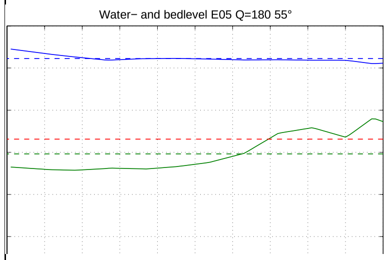
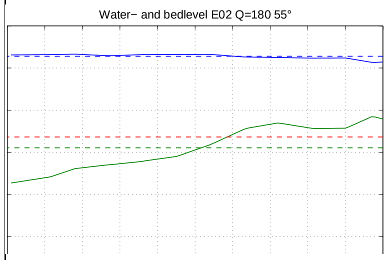
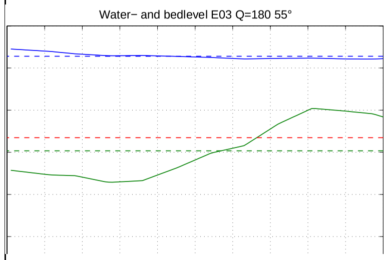
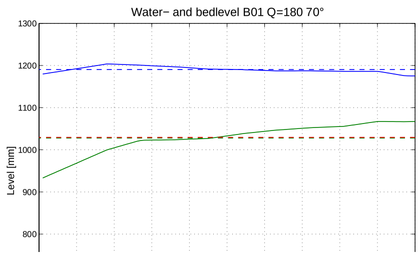
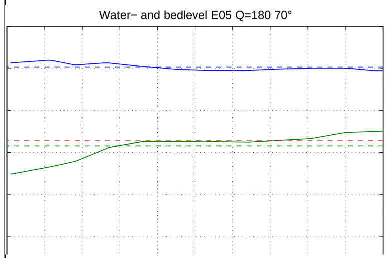
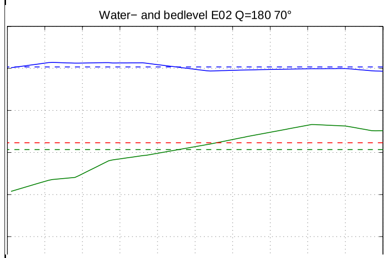
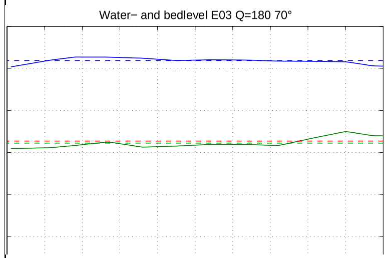
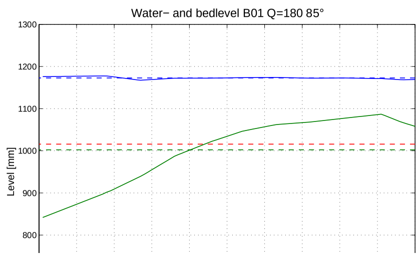
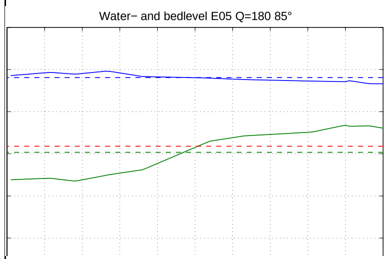
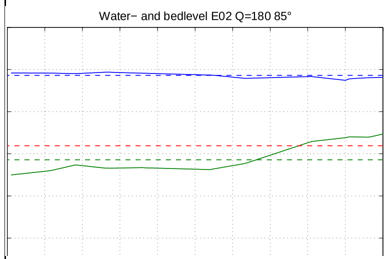
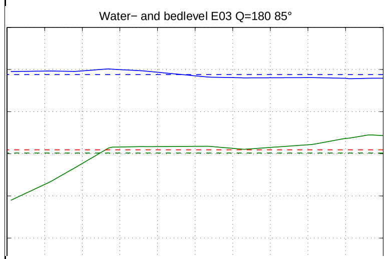
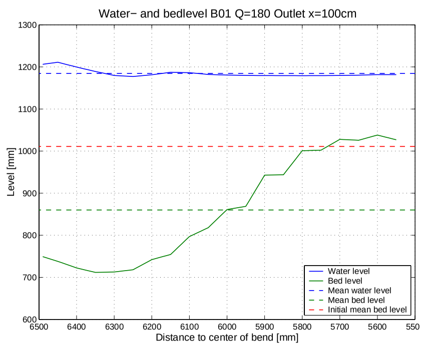
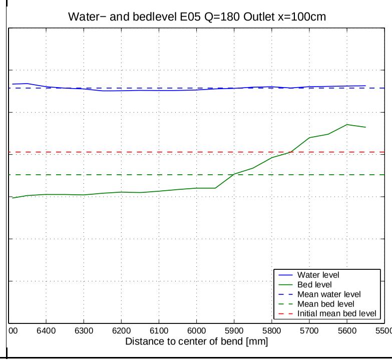
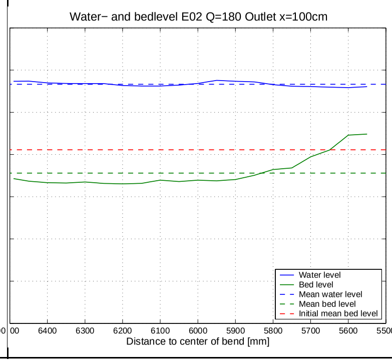
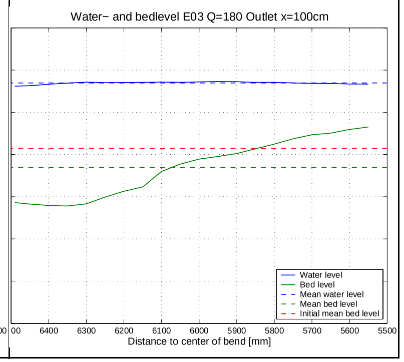
Pos.	without MR	MR-spacing 8°	MR-spacing 4°	MR-spacing 2°
55°				
70°				
85°				
1m				

Table 7.11: Cross sections, $S_0 = 0.50\%$, $Q=180$ l/s, mr-depth = 40 mm

7.12 Cross sections at S_0=0.50%, Q=210 l/s, e_d=40mm

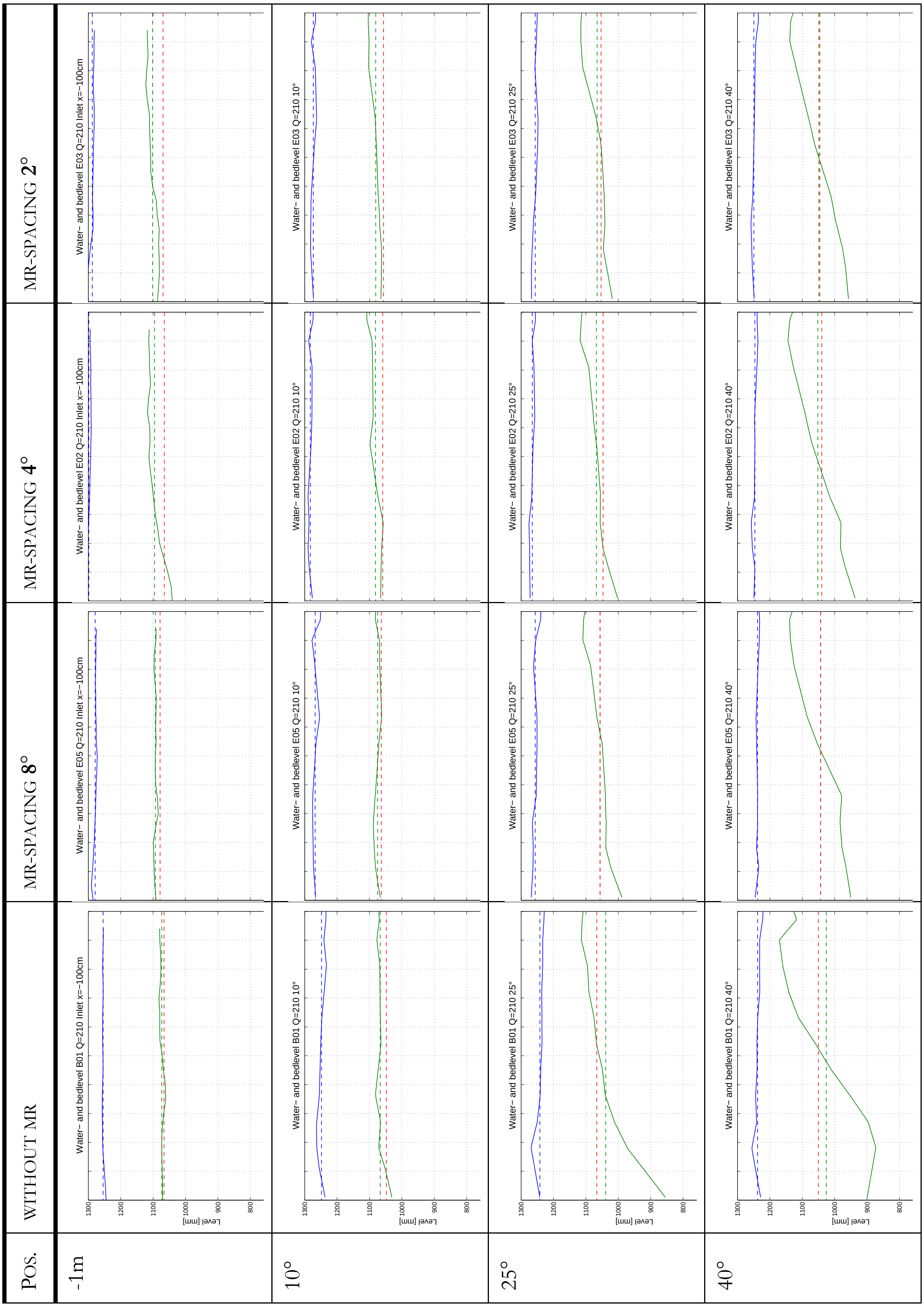


Table 7.12: Cross sections, S_0 = 0.50%, Q=210 l/s, mr-depth = 40 mm

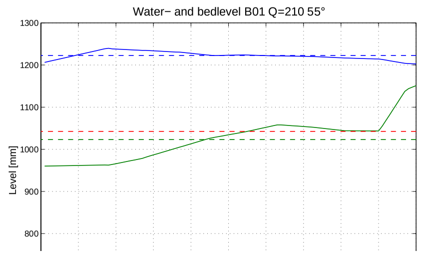
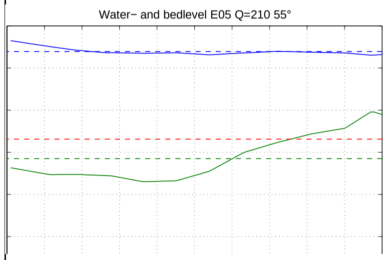
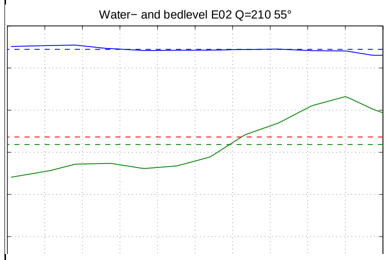
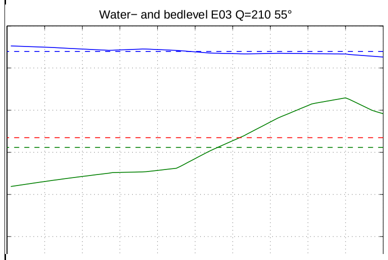
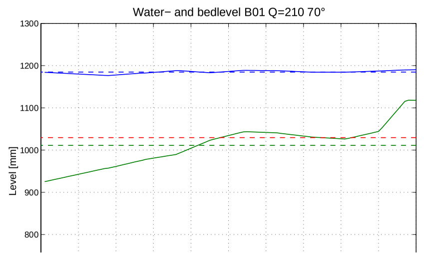
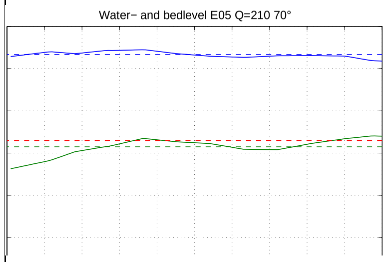
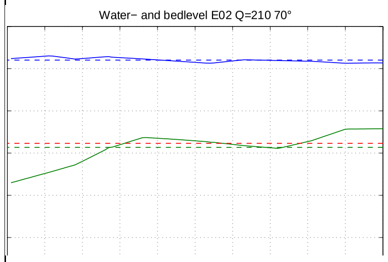
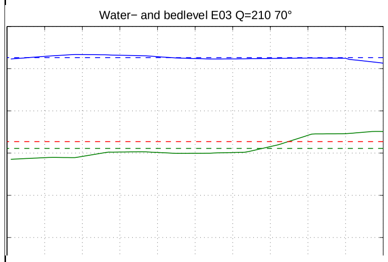
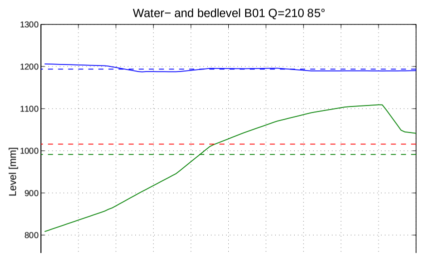
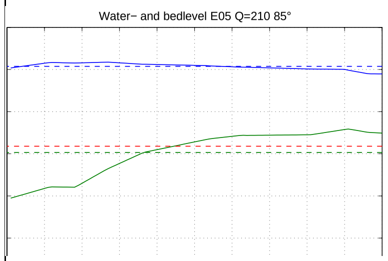
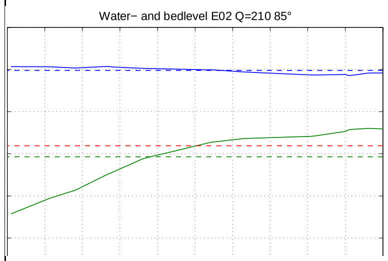
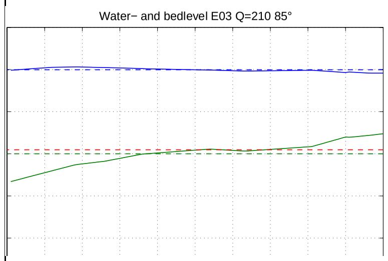
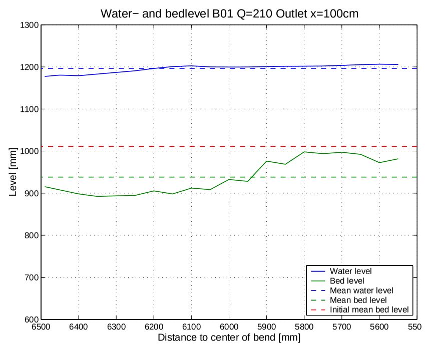
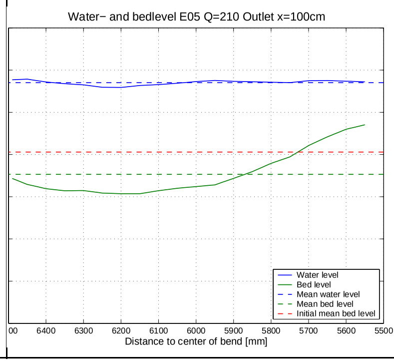
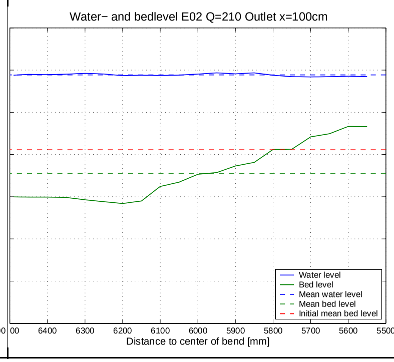
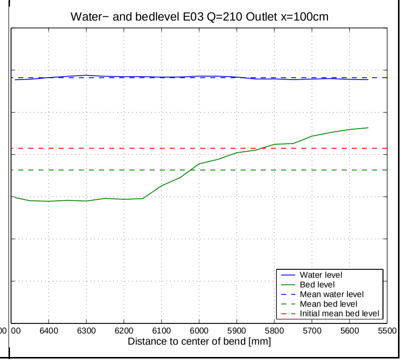
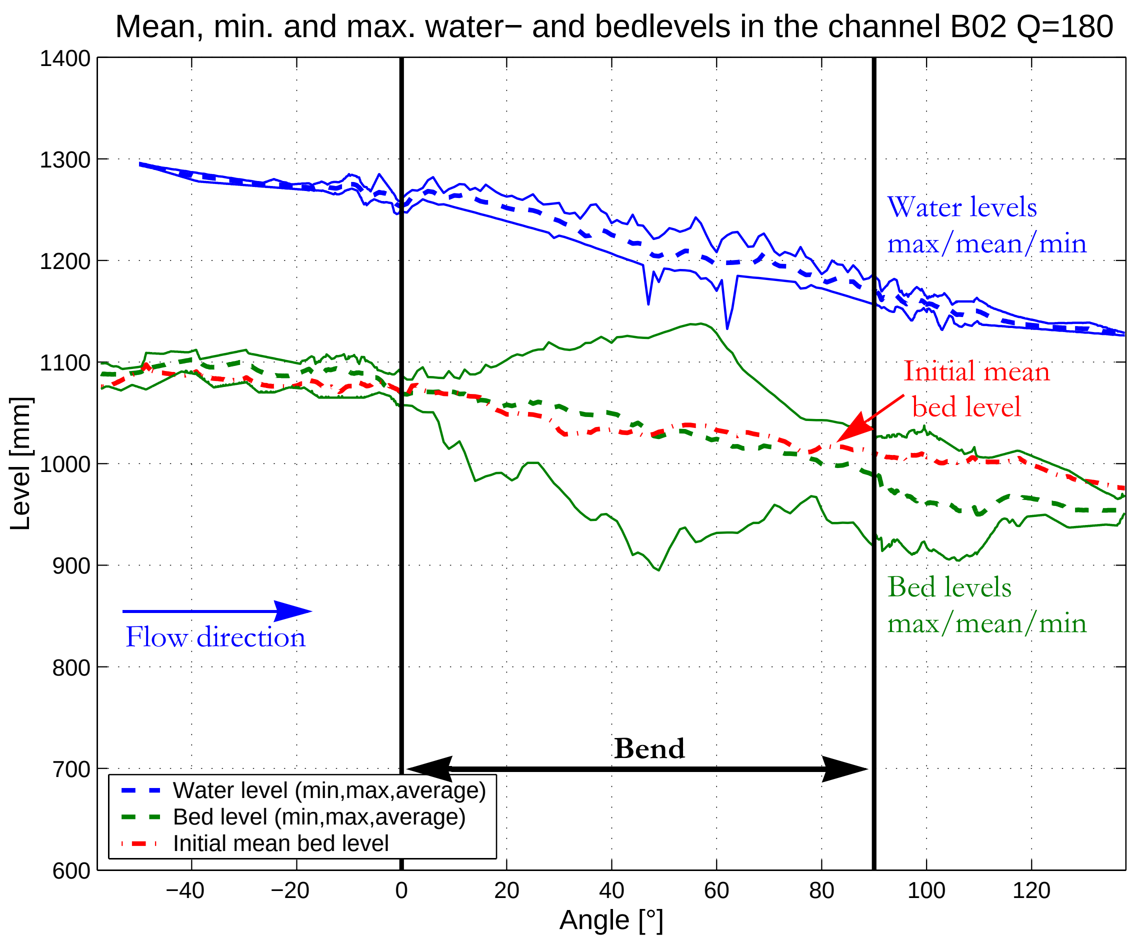
Pos.	WITHOUT MR	MR-SPACING 8°	MR-SPACING 4°	MR-SPACING 2°
55°				
70°				
85°				
1m				

Table 7.12: Cross sections, $S_0 = 0.50\%$, $Q=210$ l/s, mr-depth = 40 mm

Appendix 8

Longitudinal equilibrium average / min. and max. bed and water profiles

This Appendix gives the final water surface compared to a horizontal average surface over the whole channel (average of all data points). The vertical axis is stretched compared to the horizontal one.



Additional information can be found in the report in Chapter 5.3.1 and 6.2.

8.1 Channel slope J_f = 0.35% - mr thickness = 20 mm

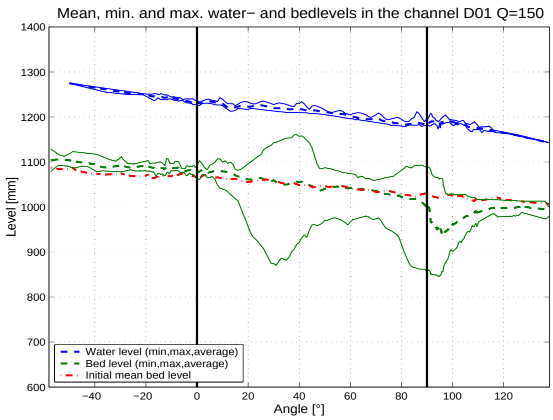
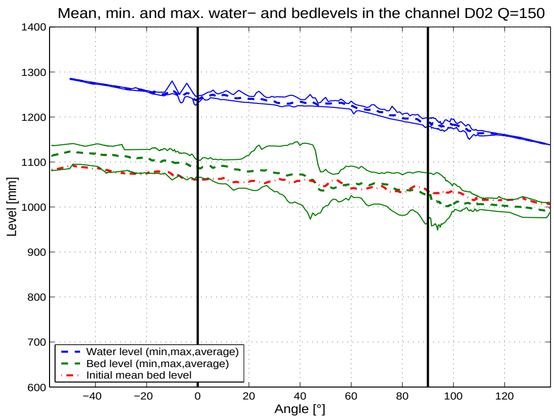
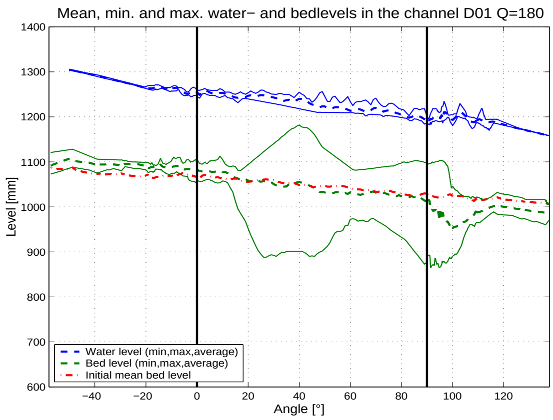
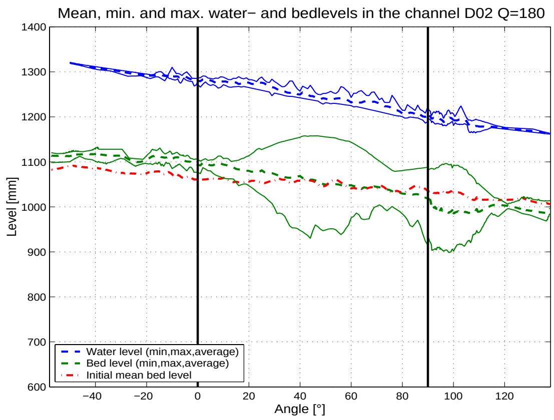
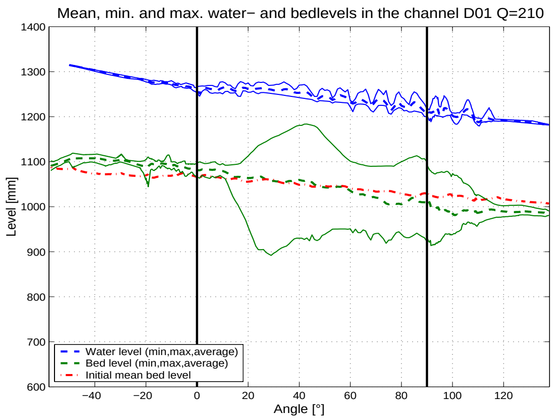
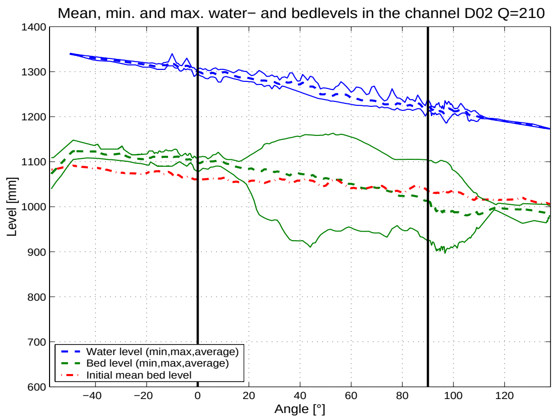
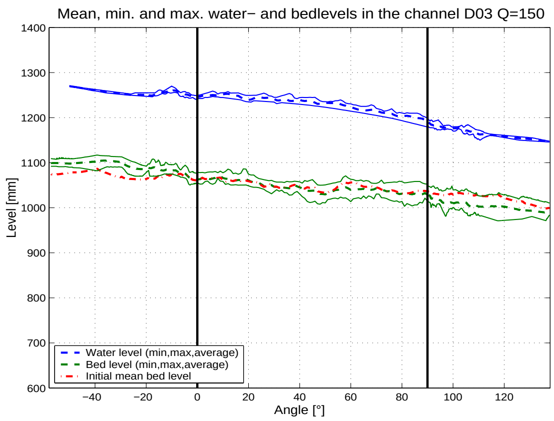
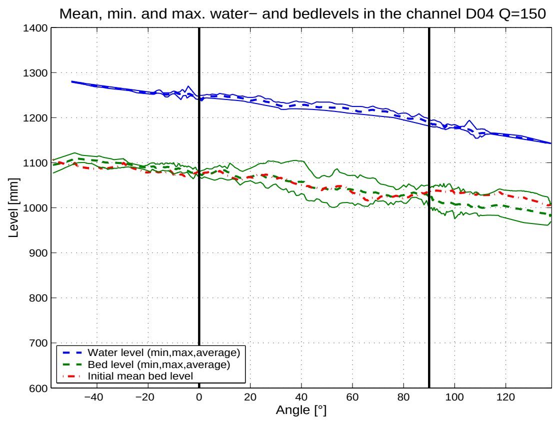
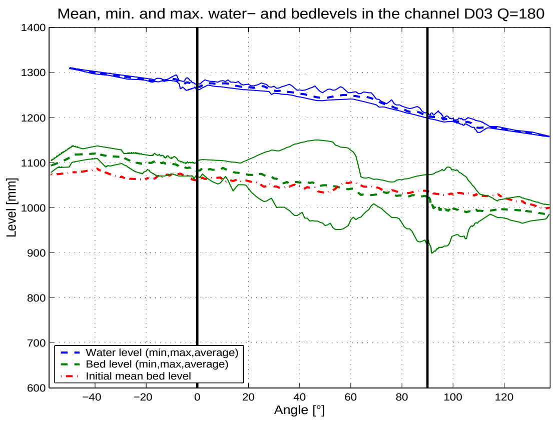
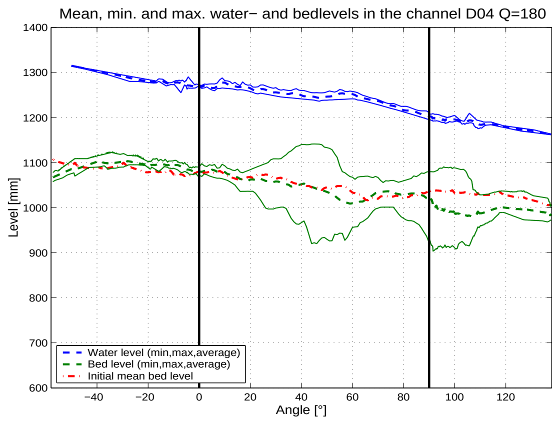
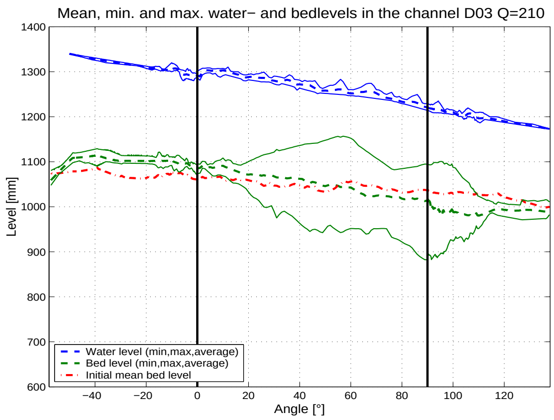
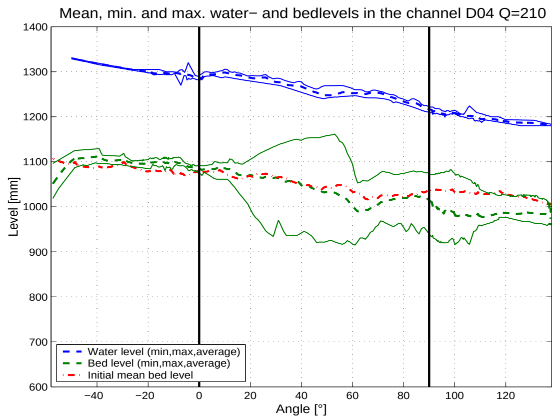
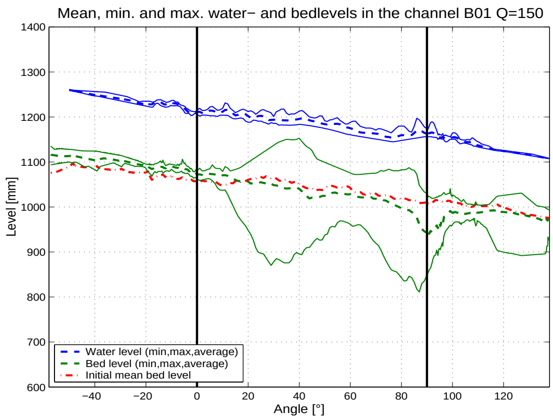
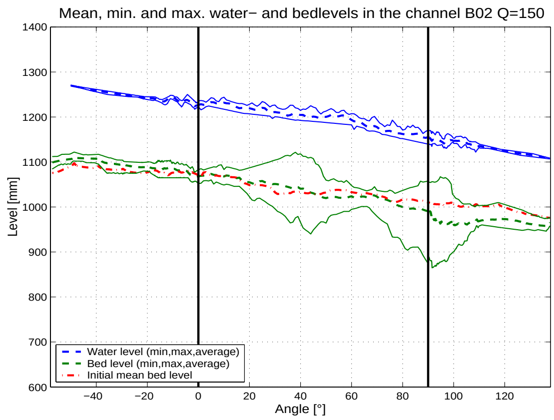
Q [L/S]	WITHOUT MR	WITH MR SPACING 4°
150		
180		
210		

Table 8.1: Longitudinal equilibrium average / min. and max. bed and water profiles

WITH MR SPACING 2°	WITH MR SPACING 1°
	
	
	

J_f = *0.35% - mr thickness = 20 mm*

8.2 *Channel slope J_f = 0.50% - mr thickness = 20 mm*

<table>
<tr><th>Q
[L/S]</th><th>WITHOUT MR</th><th>WITH MR
SPACING 4°</th></tr>
<tr><td>150</td><td>
</td><td>
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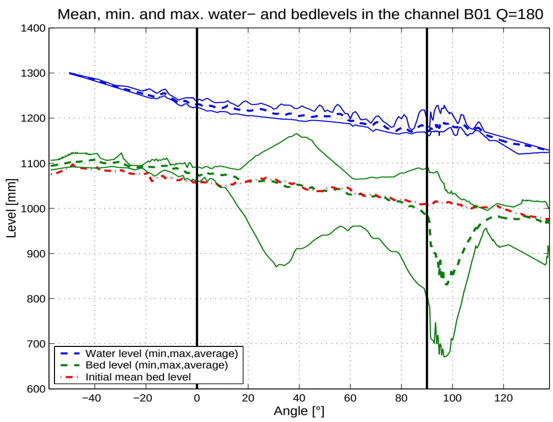
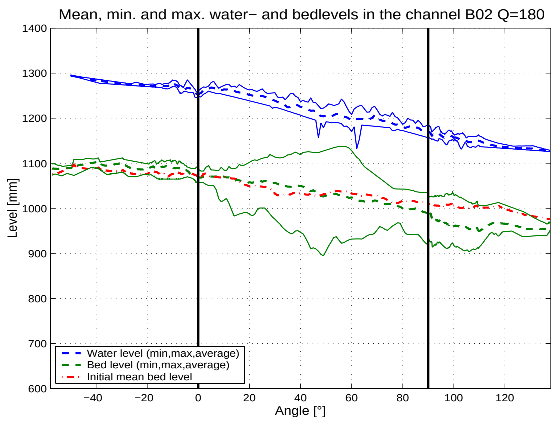
<tr><td>180</td><td>
</td><td>
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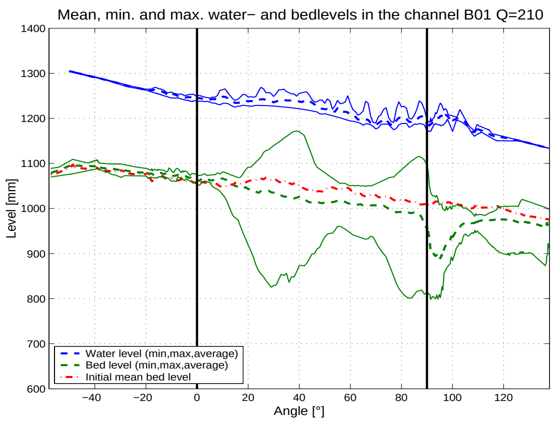
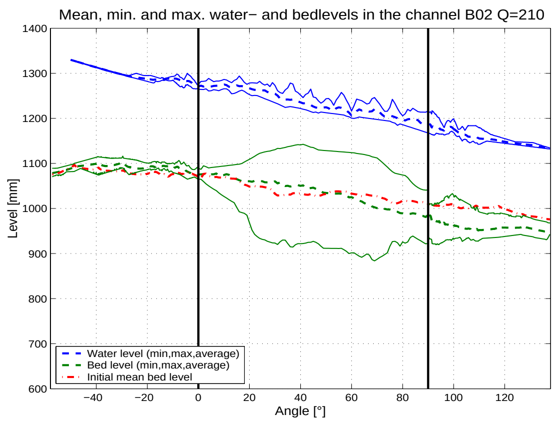
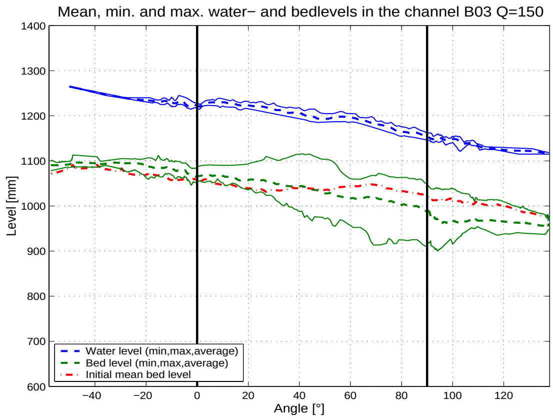
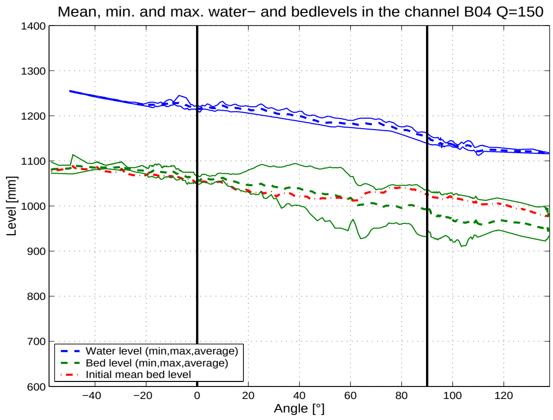
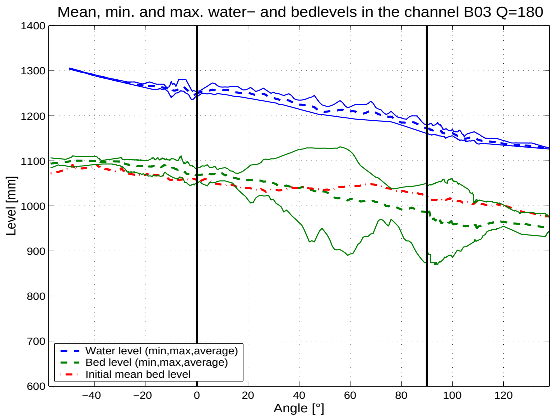
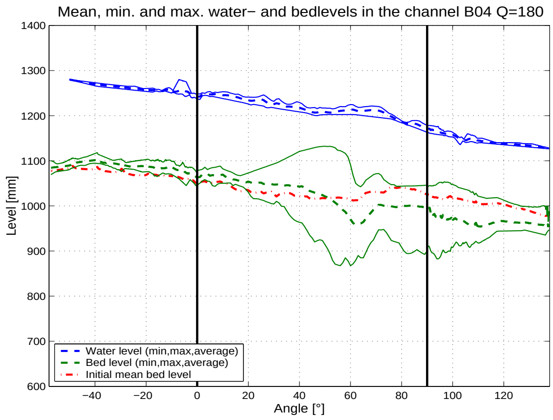
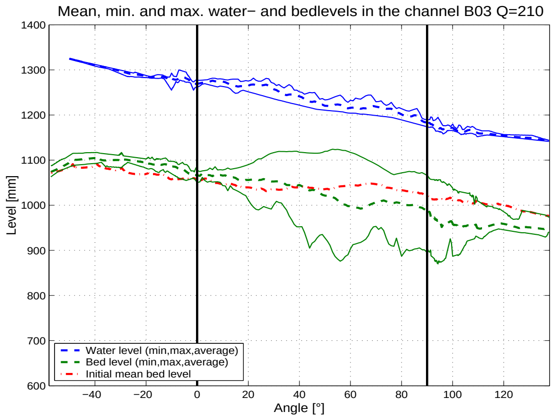
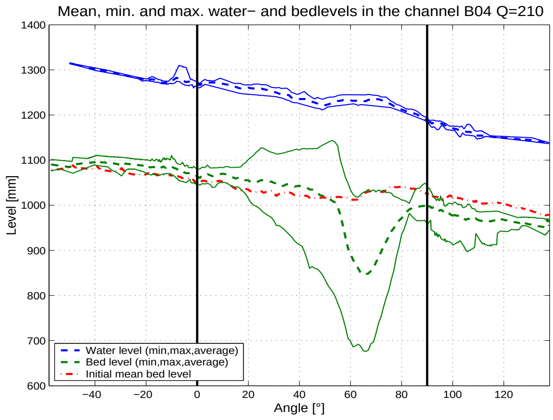
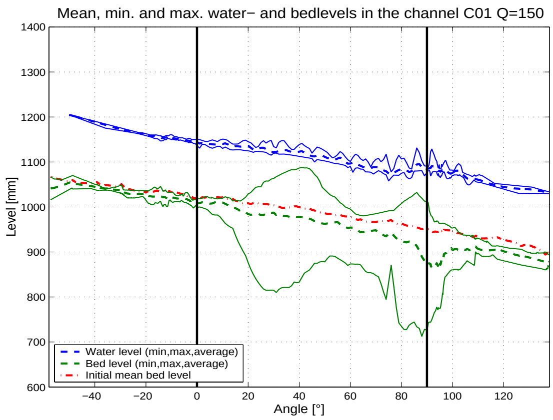
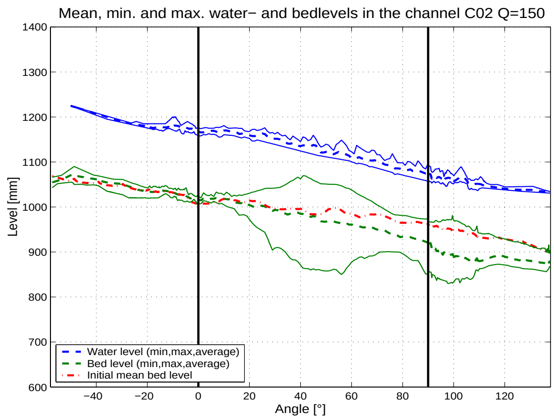
<tr><td>210</td><td>
</td><td>
</td></tr>
</table>

Table 8.2: Longitudinal equilibrium average / min. and max. bed and water profiles

WITH MR SPACING 2°	WITH MR SPACING 1°
	
	
	

J_f *= 0.50% - mr thickness = 20 mm*

8.3 *Channel slope J_f = 0.70% - mr thickness = 20 mm*

<table>
<tr><th>Q
[L/S]</th><th>WITHOUT MR</th><th>WITH MR
SPACING 4°</th></tr>
<tr><td>150</td><td>
</td><td>
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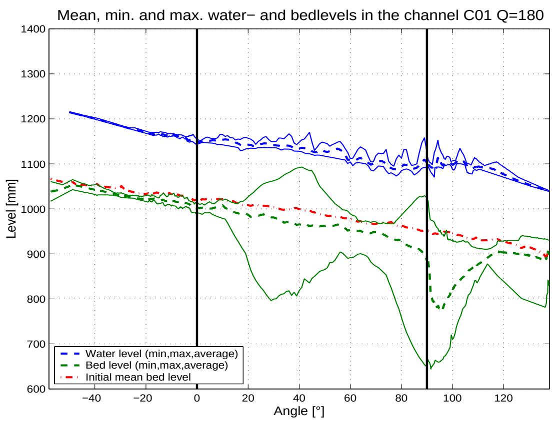
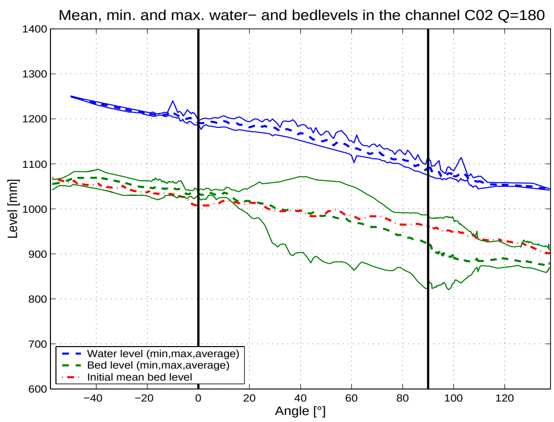
<tr><td>180</td><td>
</td><td>
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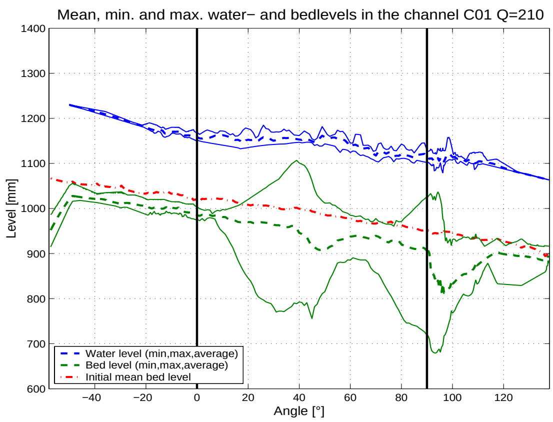
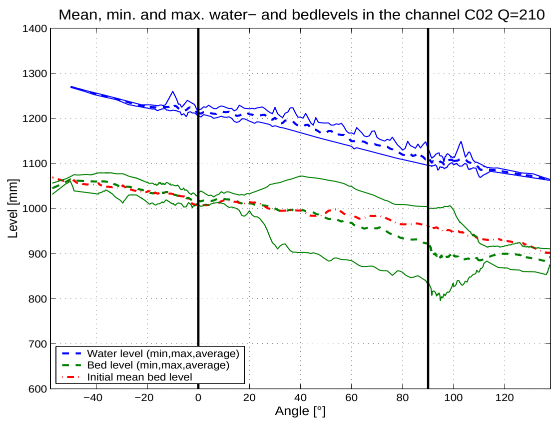
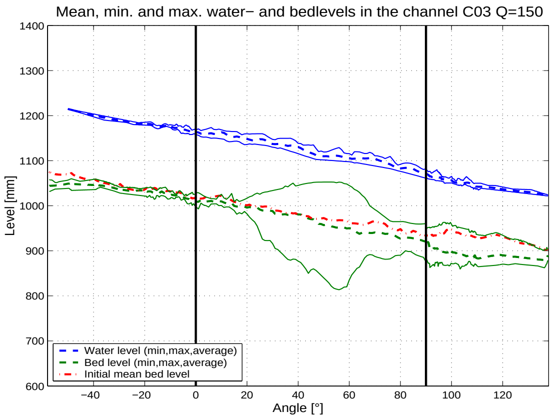
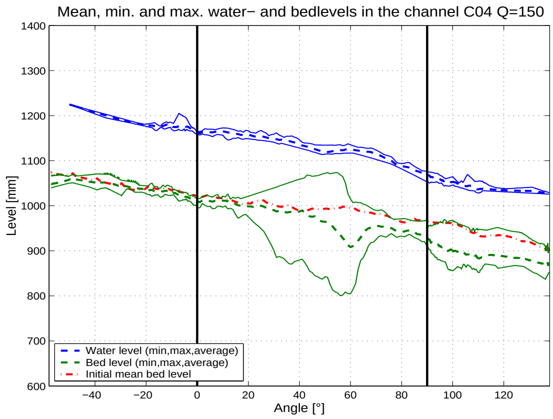
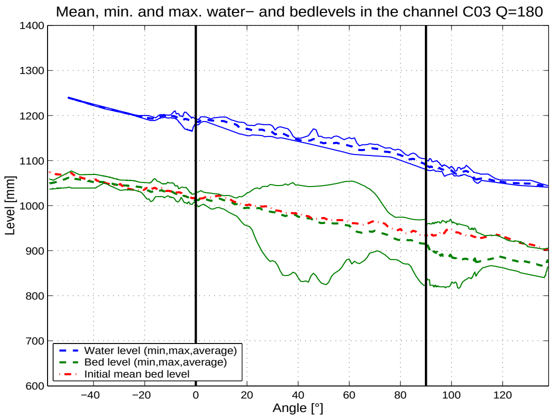
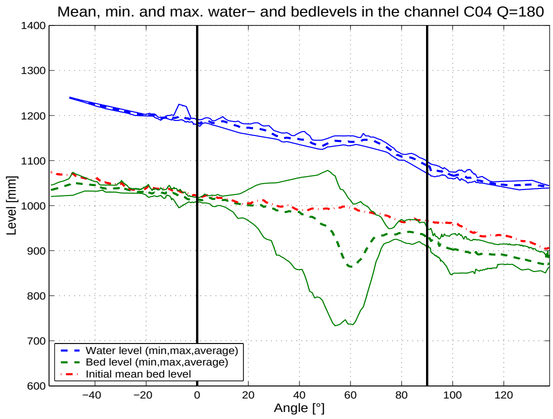
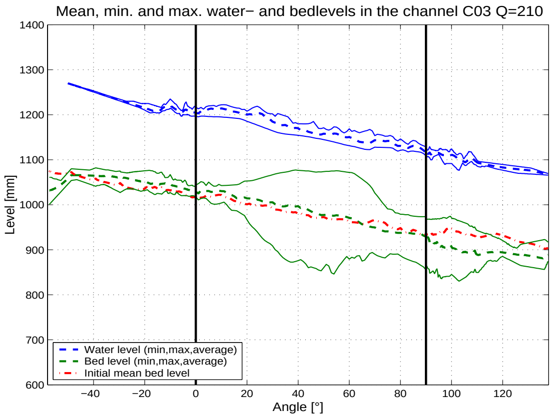
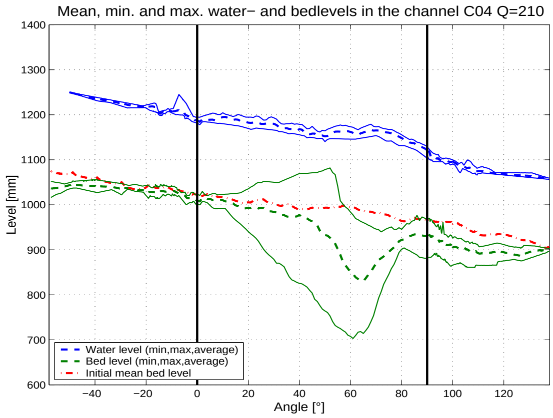
<tr><td>210</td><td>
</td><td>
</td></tr>
</table>

Table 8.3: Longitudinal equilibrium average / min. and max. bed and water profiles

WITH MR SPACING 2°	WITH MR SPACING 1°
	
	
	

J_f *= 0.70% - mr thickness = 20 mm*

8.4 Channel slope J_f = 0.50% - mr thickness = 40 mm

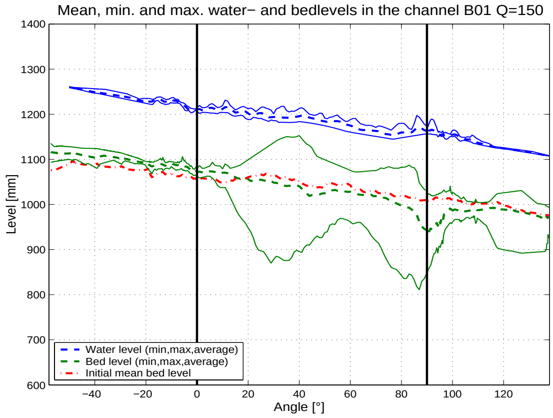
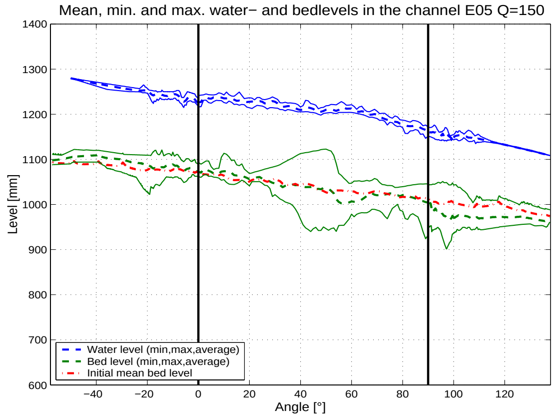
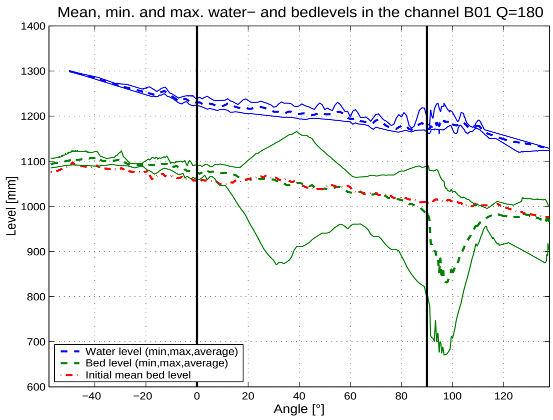
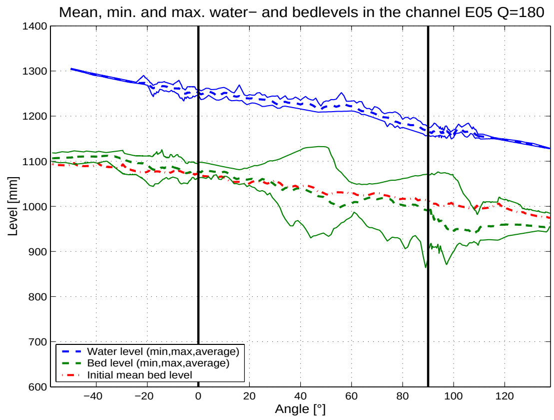
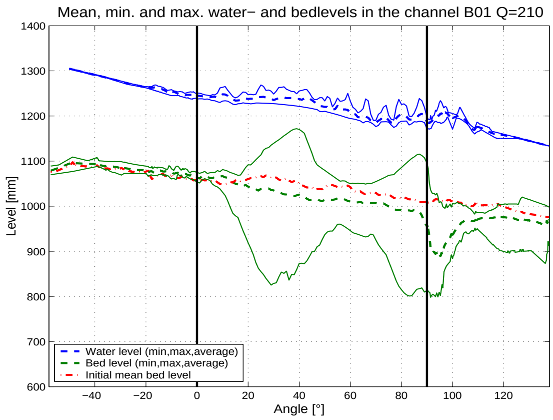
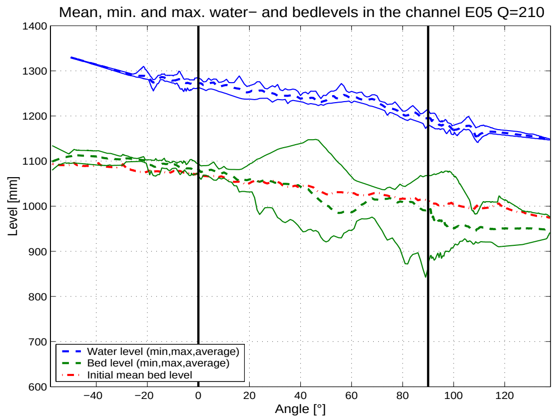
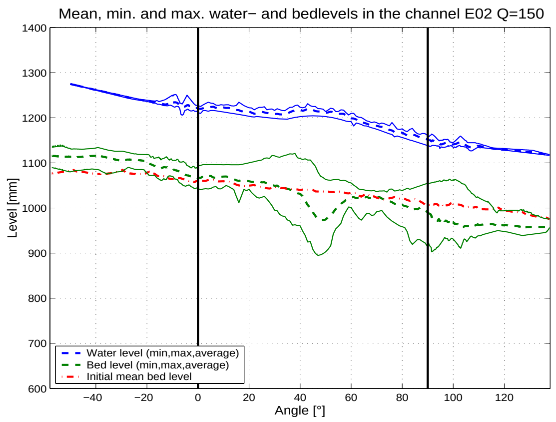
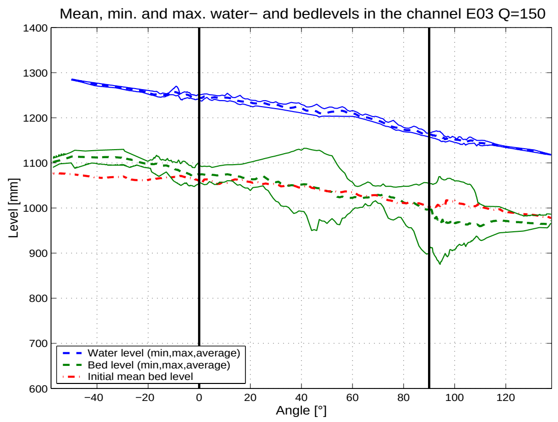
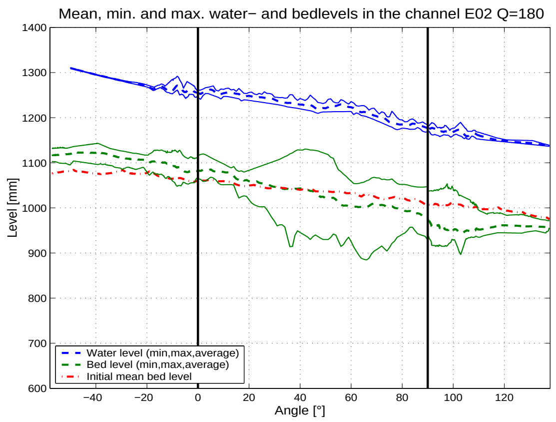
Q [L/S]	WITHOUT MR COPY FROM A.8.2	WITH MR SPACING 8°
150		
180		
210		

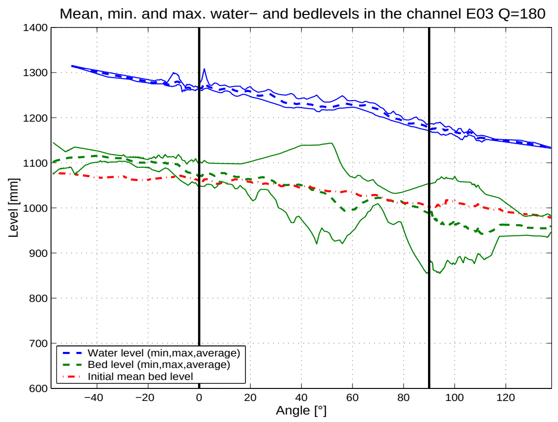
Table 8.4: Longitudinal equilibrium average / min. and max. bed and water profiles

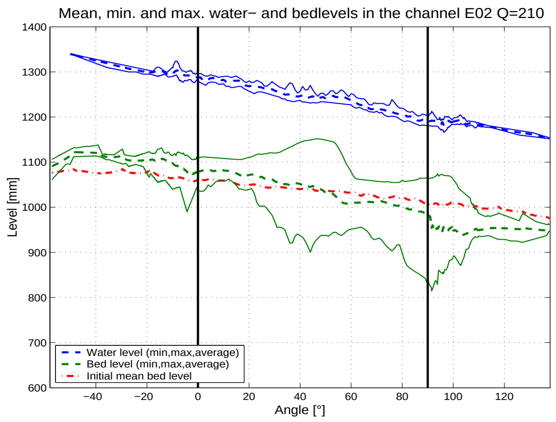
WITH MR SPACING 4° | WITH MR SPACING 2°

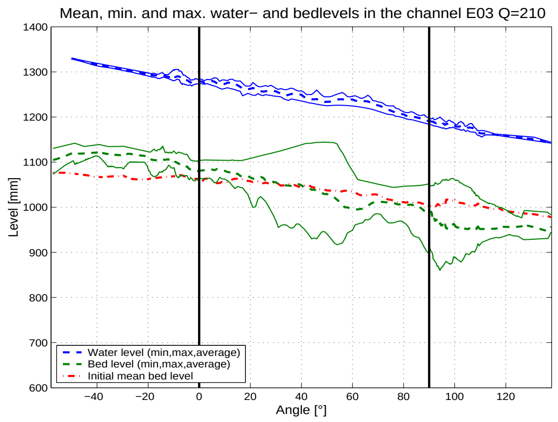












J_f *= 0.50% - mr thickness = 40 mm*

APPENDIX 9

GRAIN SIZE DISTRIBUTIONS

This Appendix gives the grain size distributions of the armoring layer after the tests in the first and second scour holes on the outer side of the bend (in the scour) as well as on the inner bank. Furthermore the grain size distribution of one of the last samples taken at the outlet is given for each performed test (except the complementary tests E).

Additional information can be found in the report in Chapter 5.3.1 and 6.5.

9.1 Grain size distribution in the first scour

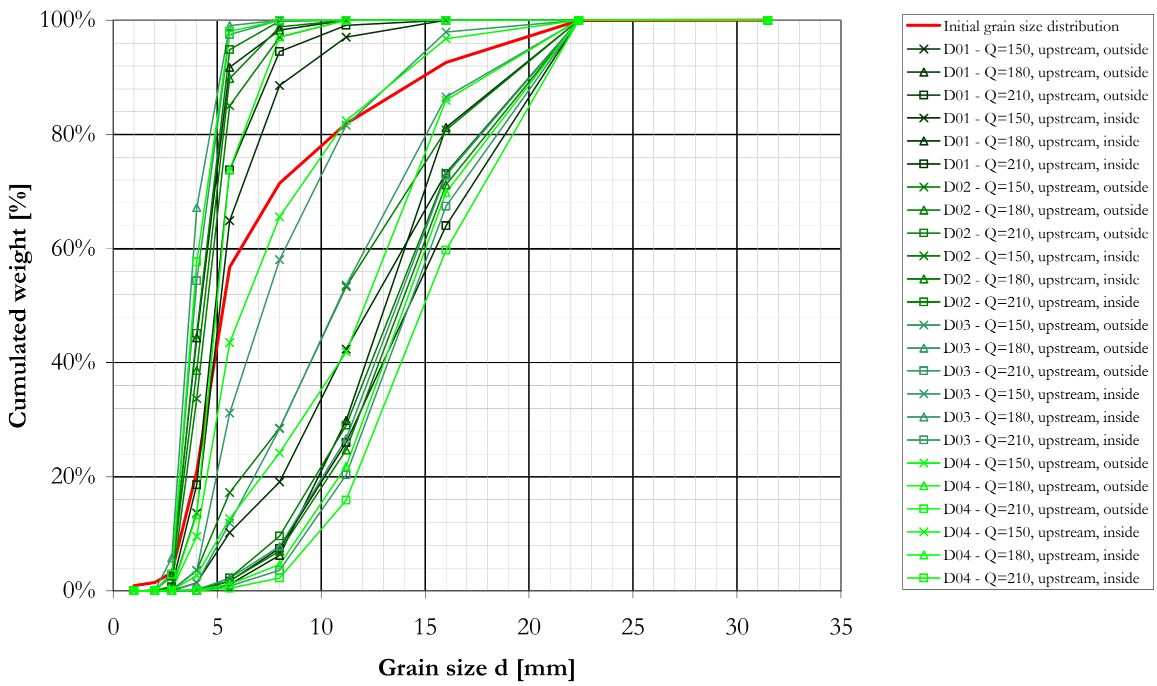


Figure 9.1: Grain size distribution - first scour, S_0 = 0.35%, without mr (x01) and with ribs every 4, 2, 1° (x02...x04), e_d = 20mm

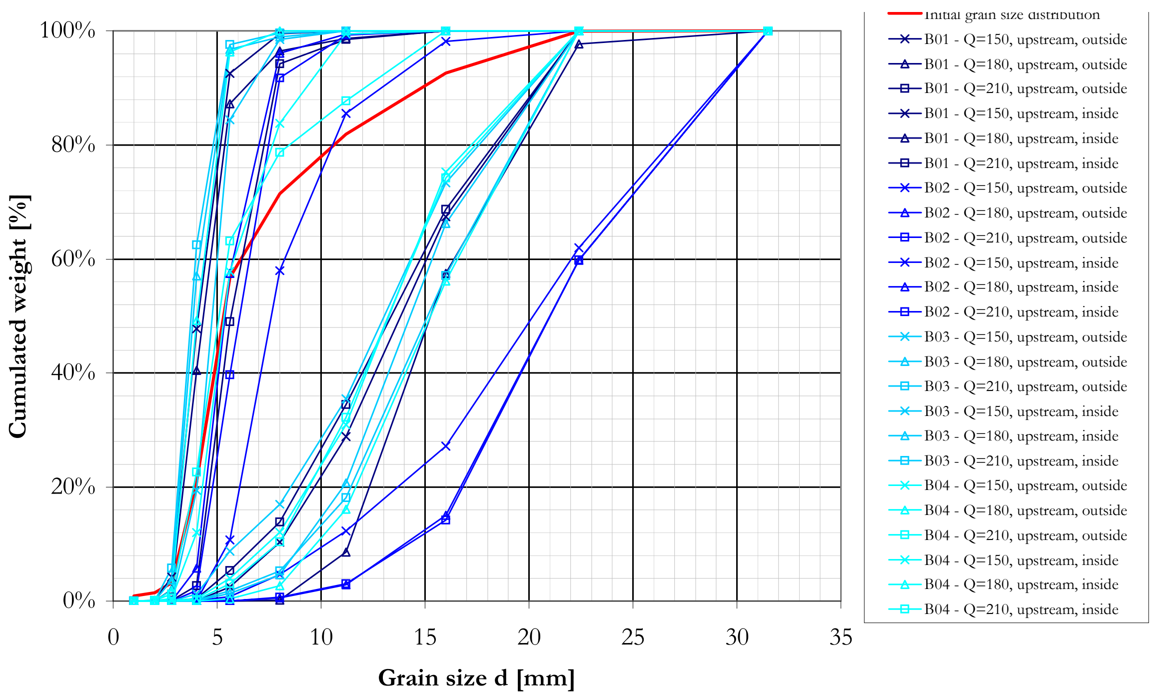


Figure 9.2: Grain size distribution - first scour, S_0 = 0.50%, without mr (x01) and with ribs every 4, 2, 1° (x02...x04), e_d = 20mm

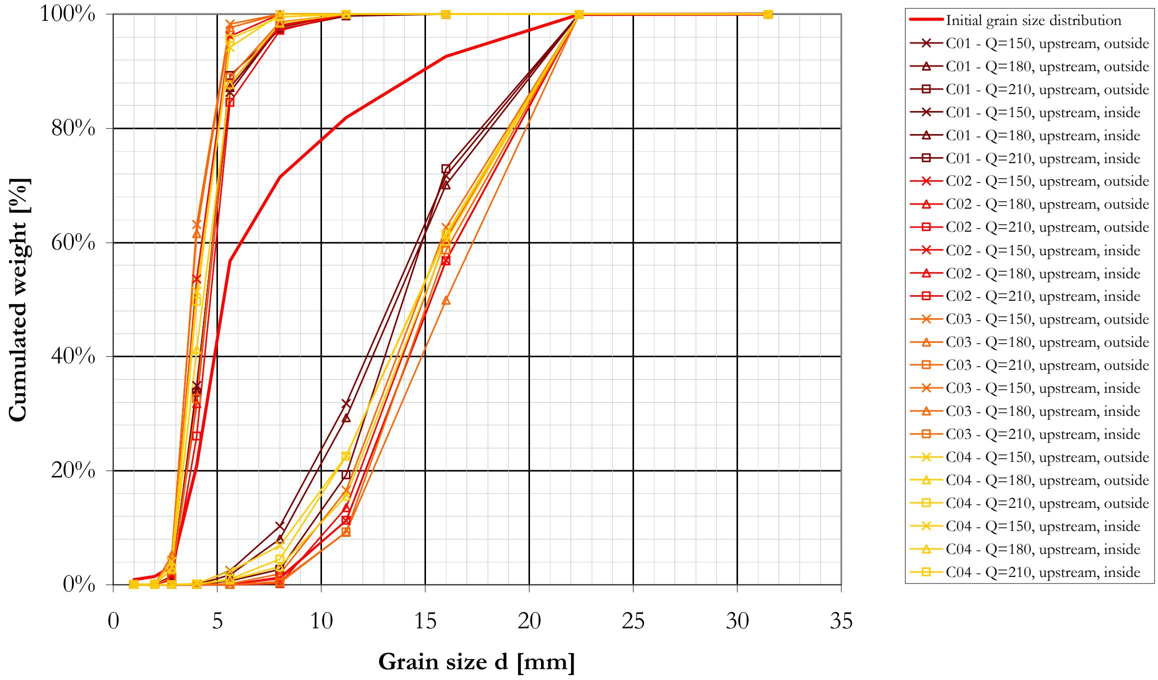


Figure 9.3: Grain size distribution - first scour, S_0 = 0.70%, without mr (x01) and with ribs every 4, 2, 1° (x02...x04), e_d = 20mm

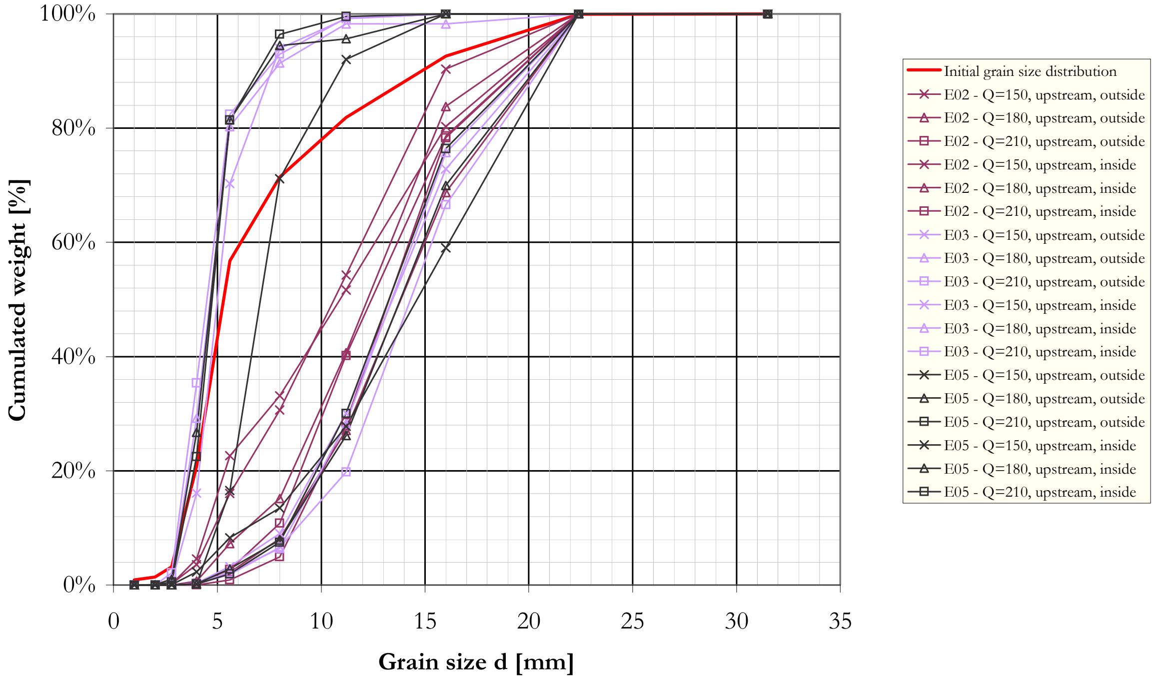


Figure 9.4: Grain size distribution - first scour, S_0 = 0.50%, without mr (x01) and with ribs every 4, 2, 8° (x02, x03, x05), e_d = 40mm

9.2 Grain size distribution in the second scour

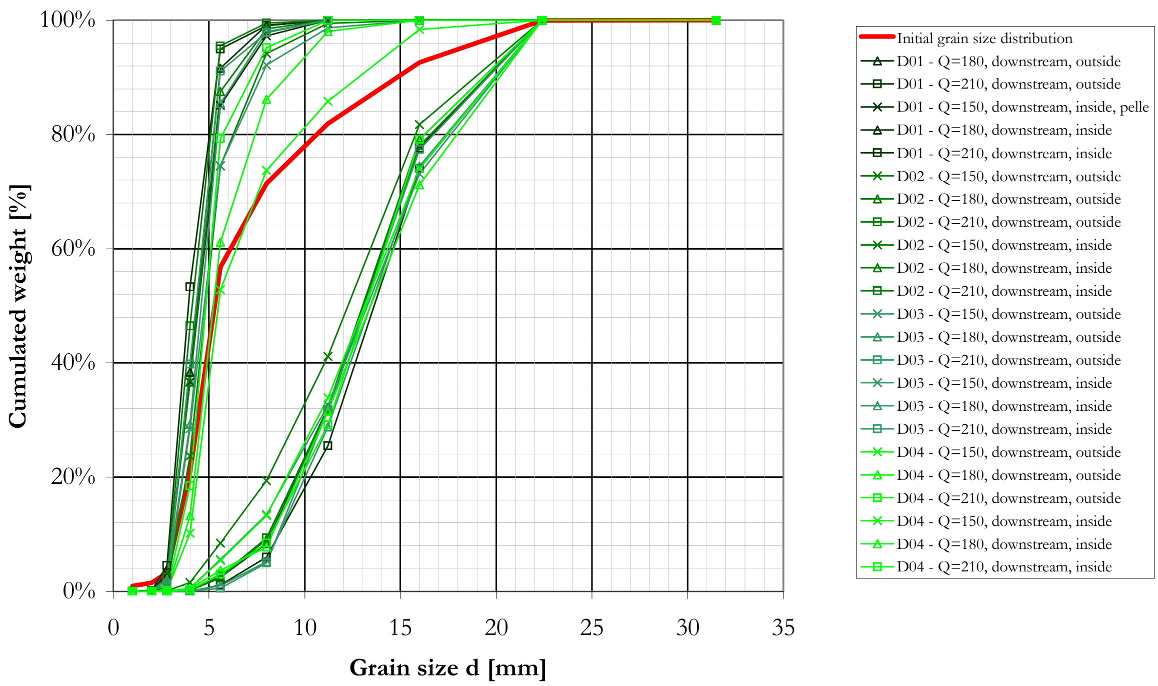


Figure 9.5: Grain size distribution - second scour, S_0 = 0.35%, without mr (x01) and with ribs every 4, 2, 1° (x02...x04), e_d = 20mm

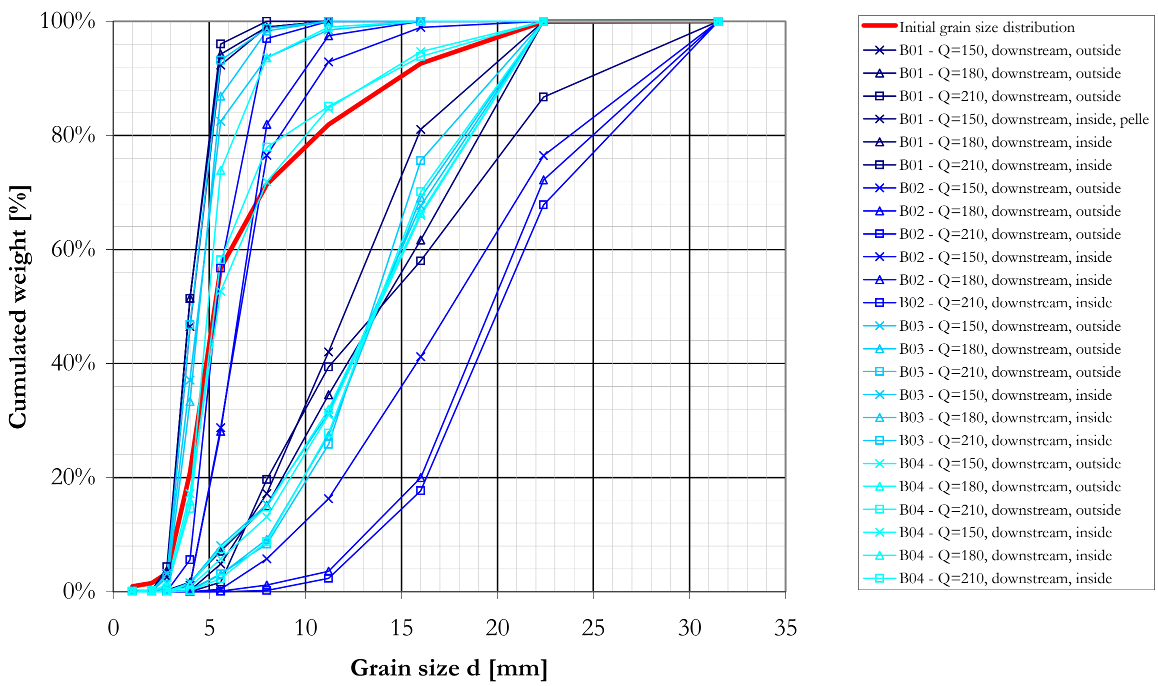


Figure 9.6: Grain size distribution - second scour, S_0 = 0.50%, without mr (x01) and with ribs every 4, 2, 1° (x02...x04), e_d = 20mm

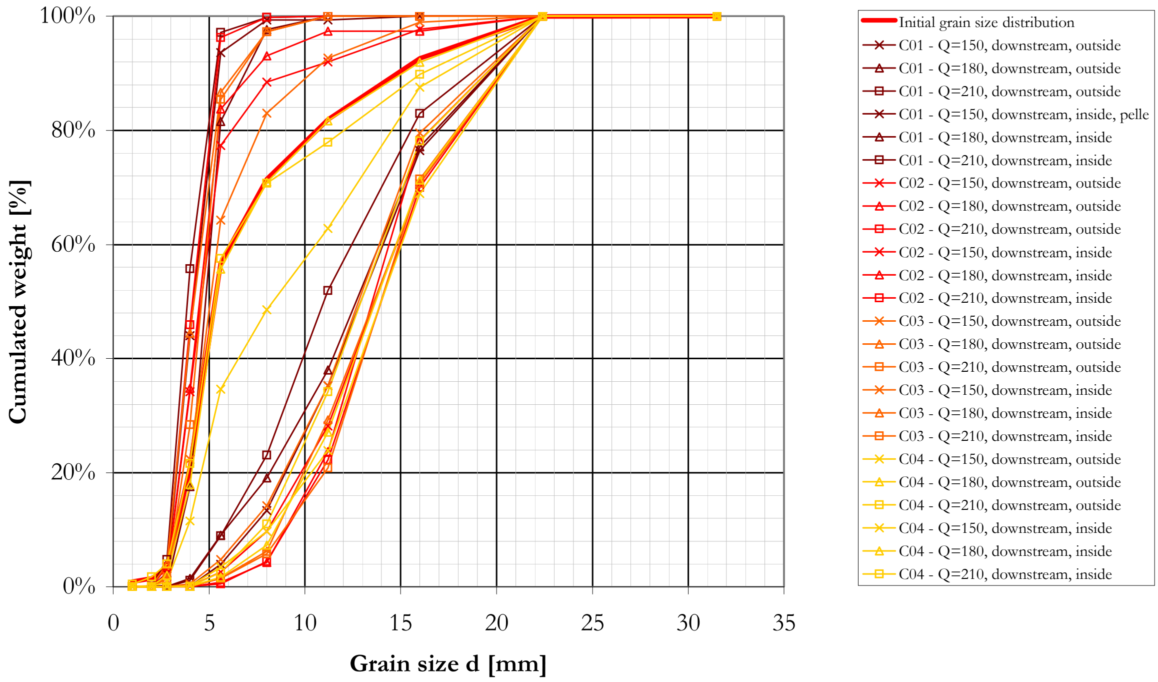


Figure 9.7: Grain size distribution - second scour, S_0 = 0.70%, without mr (x01) and with ribs every 4, 2, 1° (x02...x04), e_d = 20mm

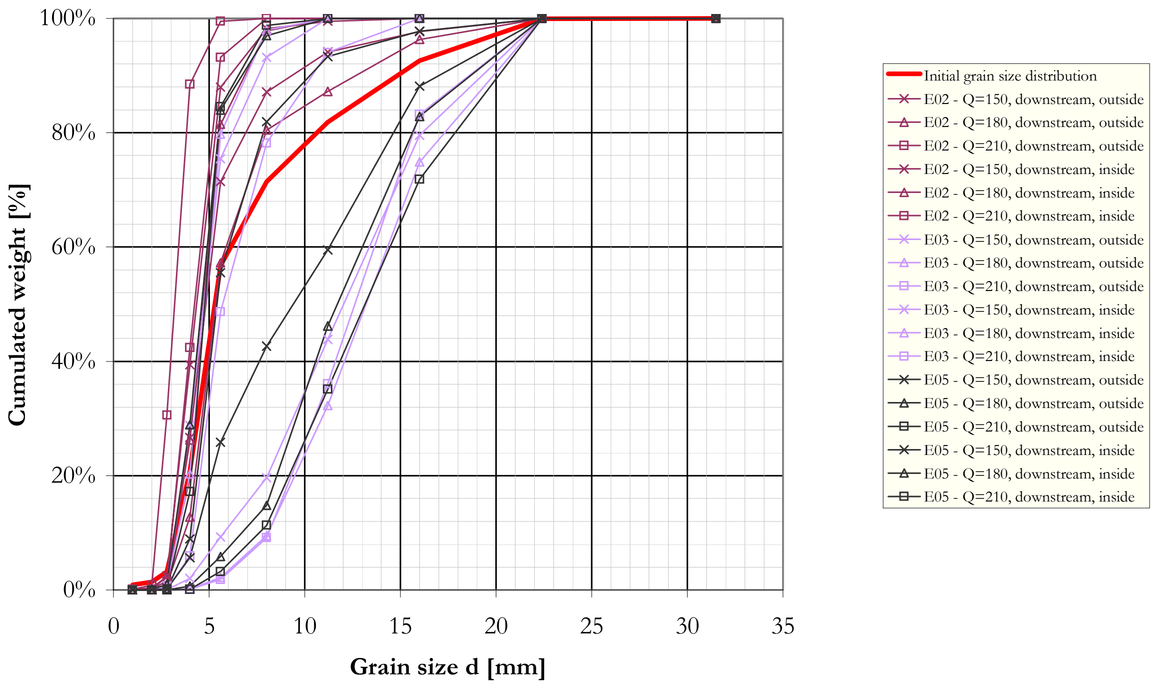


Figure 9.8: Grain size distribution - second scour, S_0 = 0.50%, without mr (x01) and with ribs every 4, 2, 8° (x02, x03, x05), e_d = 40mm

9.3 Grain size distribution of the samples at the outlet

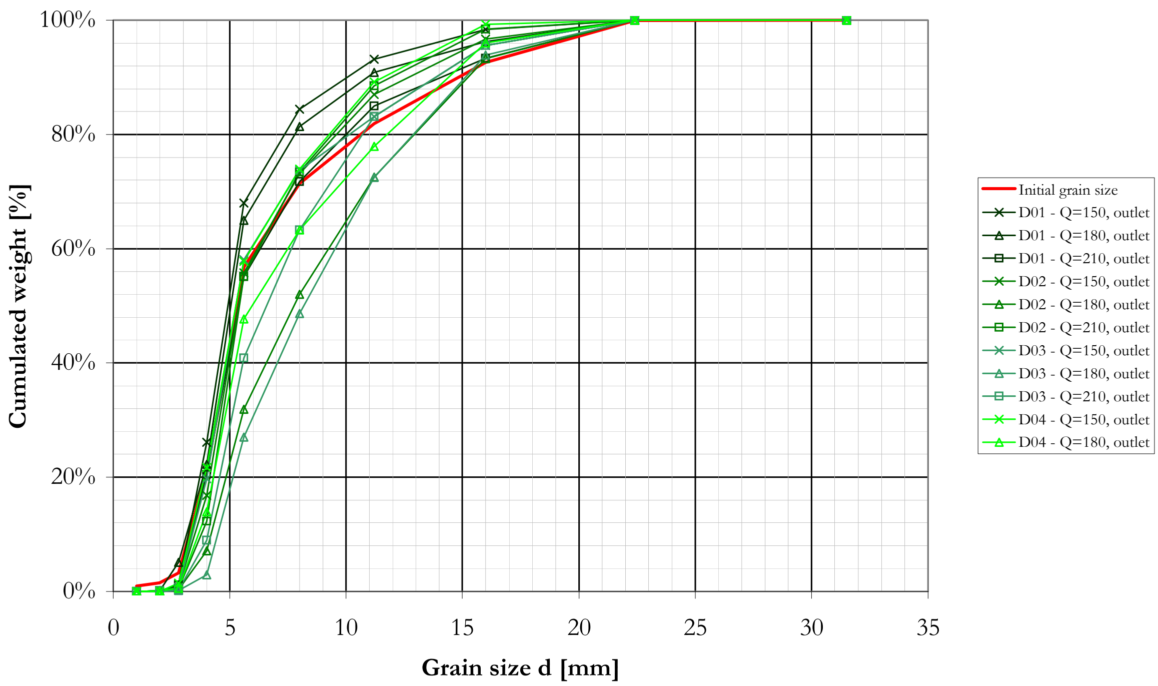


Figure 9.9: Grain size distribution - samples at the outlet, S_0 = 0.35%, without mr (x01) and with ribs every 4, 2, 1° (x02...x04), e_d = 20mm

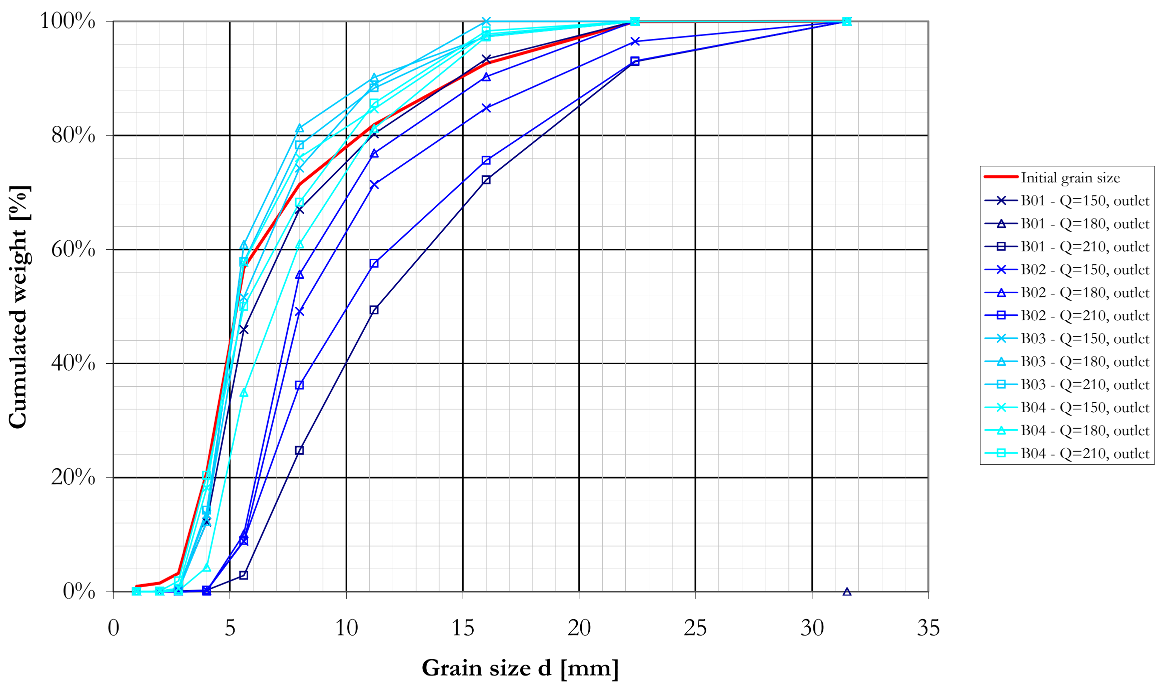


Figure 9.10: Grain size distribution - samples at the outlet, S_0 = 0.50%, without mr (x01) and with ribs every 4, 2, 1° (x02...x04), e_d = 20mm

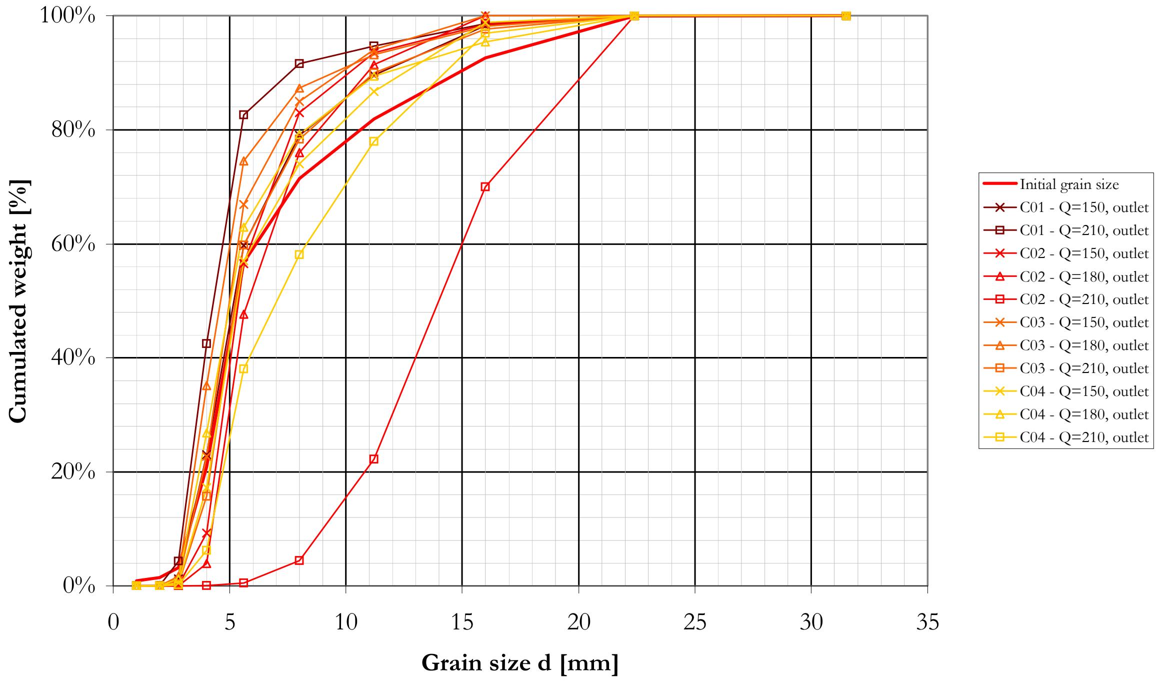


Figure 9.11: Grain size distribution - samples at the outlet, S_0 = 0.70%, without mr (x01) and with ribs every 4, 2, 1° (x02...x04), e_d = 20mm

9.4 Grain size distributions sorted by discharge

9.4.1 Q= 150 l/s

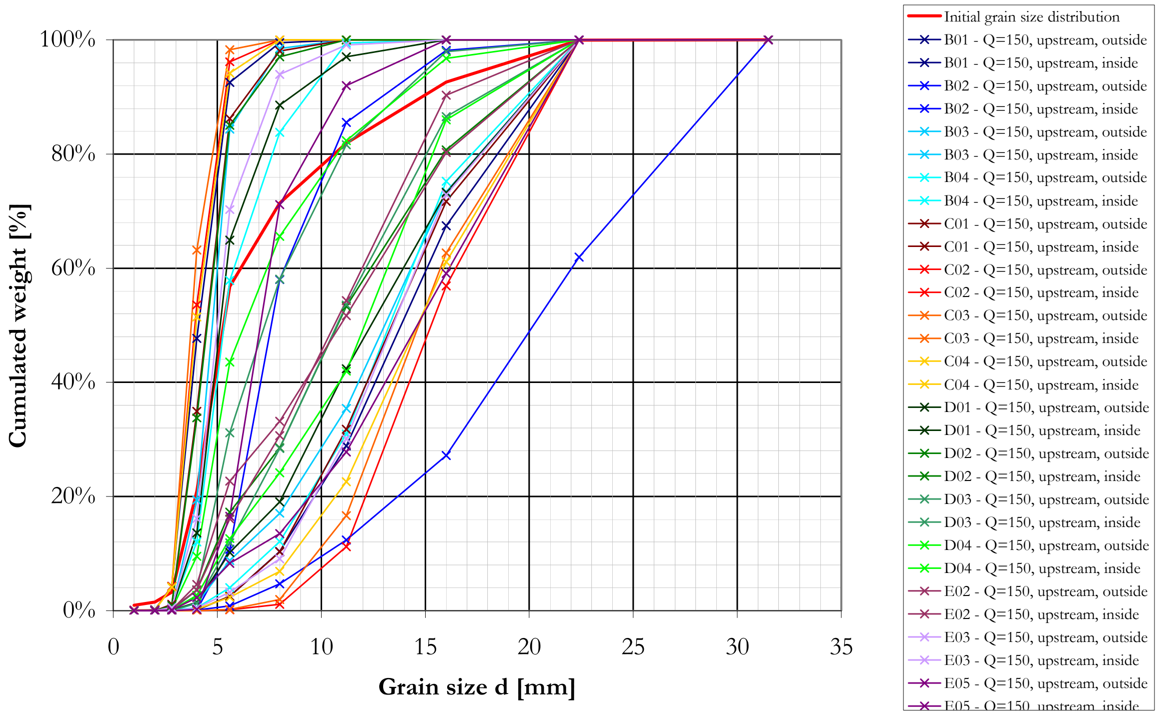


Figure 9.12: Grain size distribution - first scour, Q = 150 l/s, without mr (x01) and with ribs every 4, 2, 1, 8° (x02...x05), e_d = 20mm (cases B-D) and 40mm (E)

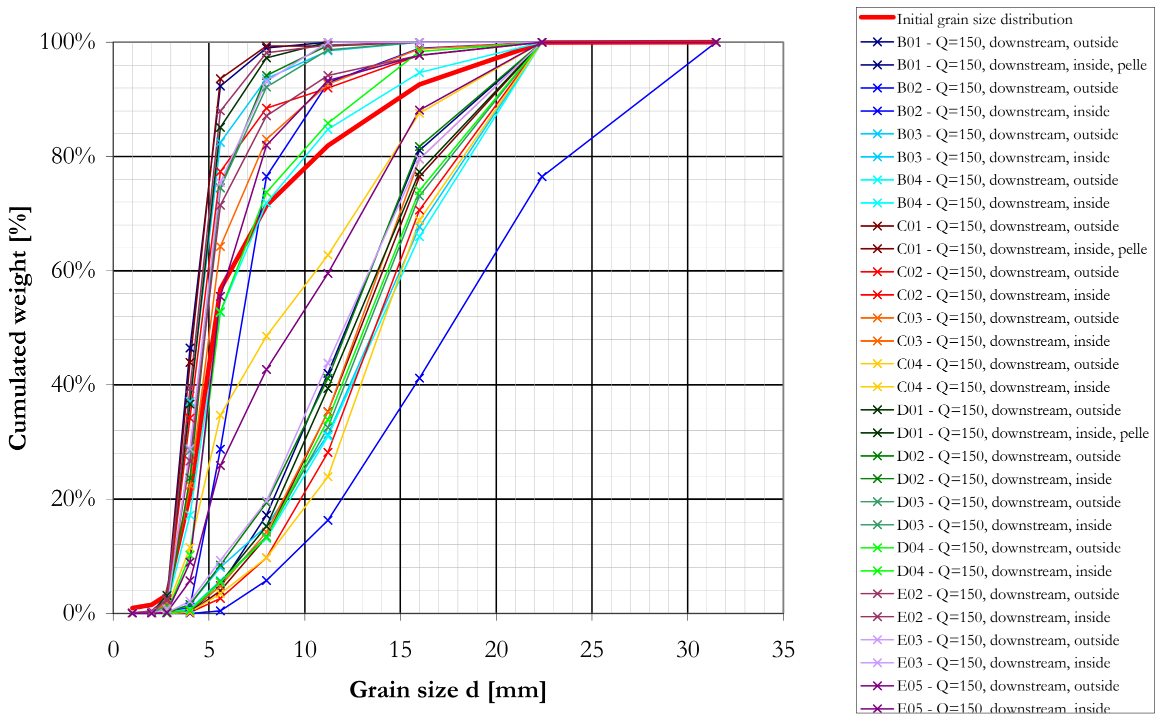


Figure 9.13: Grain size distribution - second scour, Q = 150 l/s, without mr (x01) and with ribs every 4, 2, 1, 8° (x02...x05), e_d = 20mm (cases B-D) and 40mm (E)

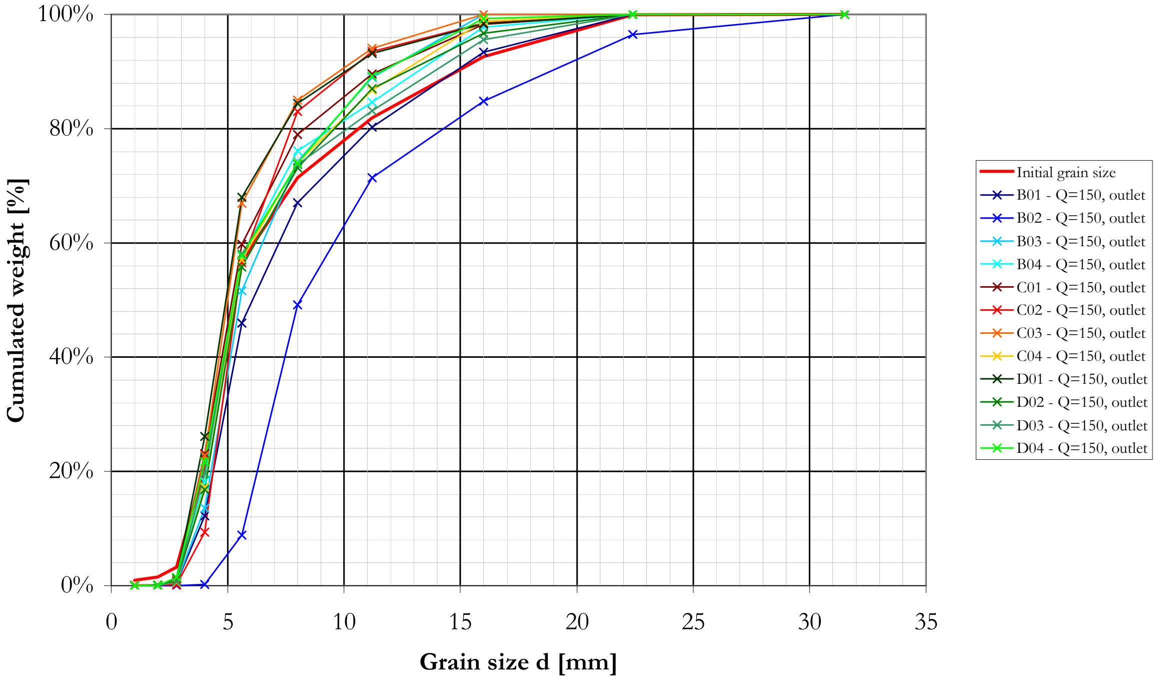


Figure 9.14: Grain size distribution - samples at the outlet, Q = 150 l/s, without mr (x01) and with ribs every 4, 2, 1, 8° (x02...x05), e_d = 20mm (cases B-D) and 40mm (E)

9.4.2 Q = 180 l/s

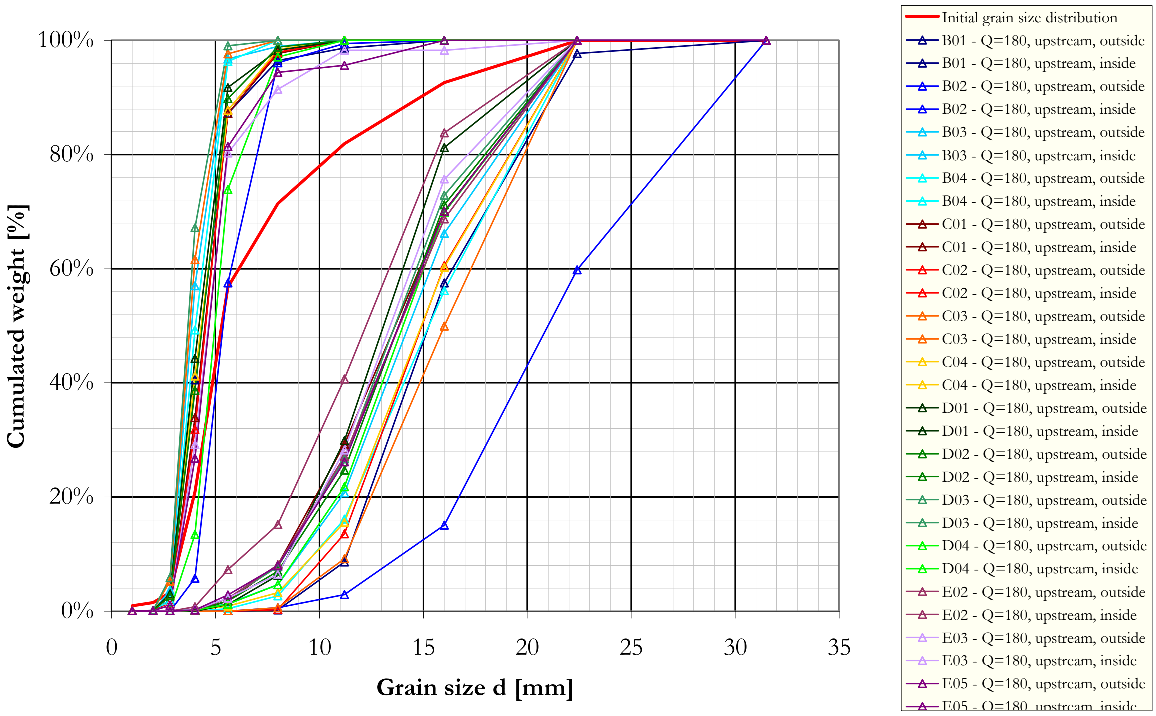


Figure 9.15: Grain size distribution - first scour, Q = 180 l/s, without mr (x01) and with ribs every 4, 2, 1, 8° (x02...x05), e_d = 20mm (cases B-D) and 40mm (E)

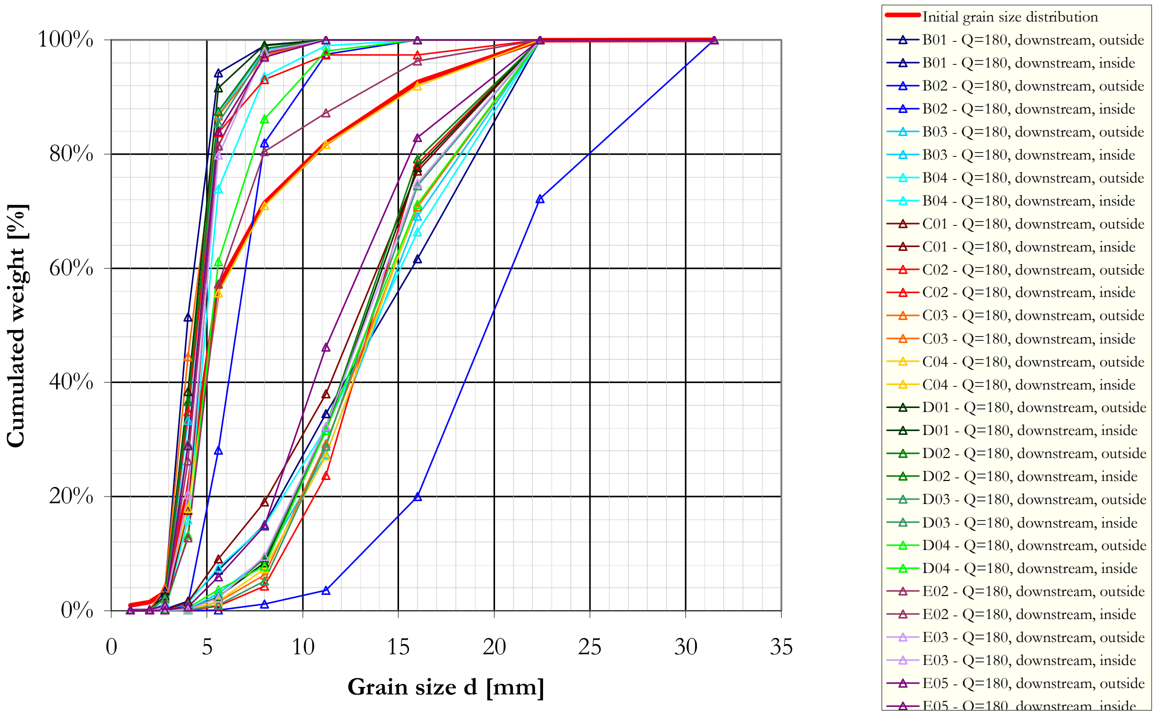


Figure 9.16: Grain size distribution - second scour, Q = 180 l/s, without mr (x01) and with ribs every 4, 2, 1, 8° (x02...x05), e_d = 20mm (cases B-D) and 40mm (E)

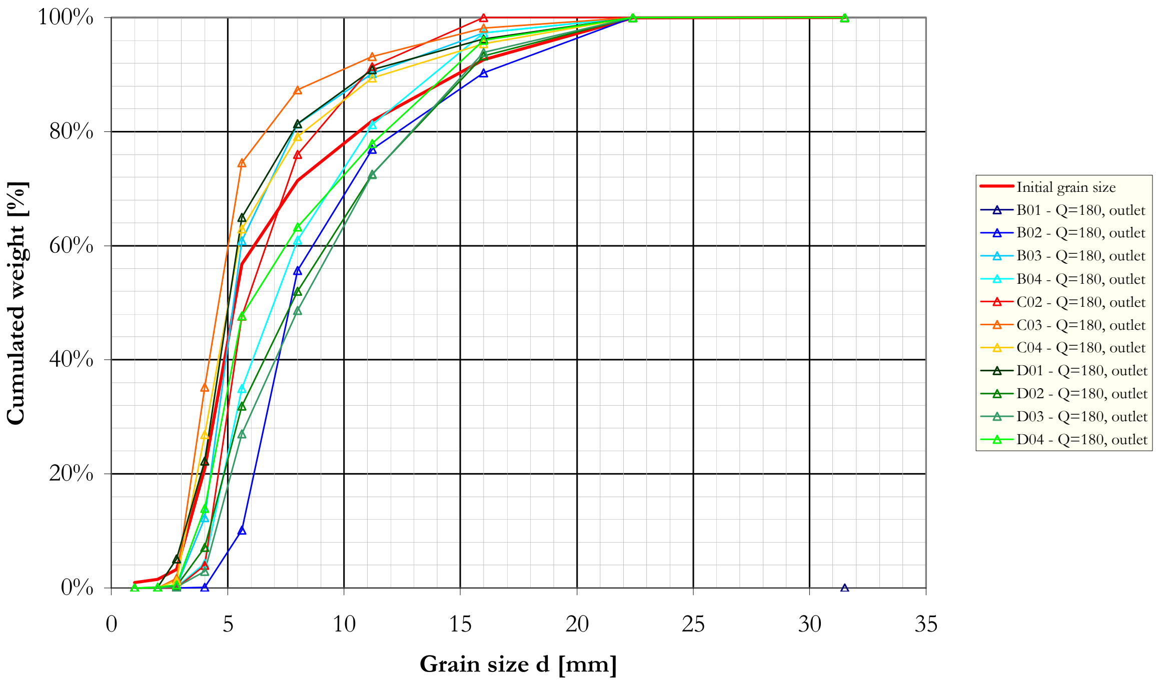


Figure 9.17: Grain size distribution - samples at the outlet, Q = 180 l/s, without mr (x01) and with ribs every 4, 2, 1, 8° (x02...x05), e_d = 20mm (cases B-D) and 40mm (E)

9.4.3 Q = 210 l/s

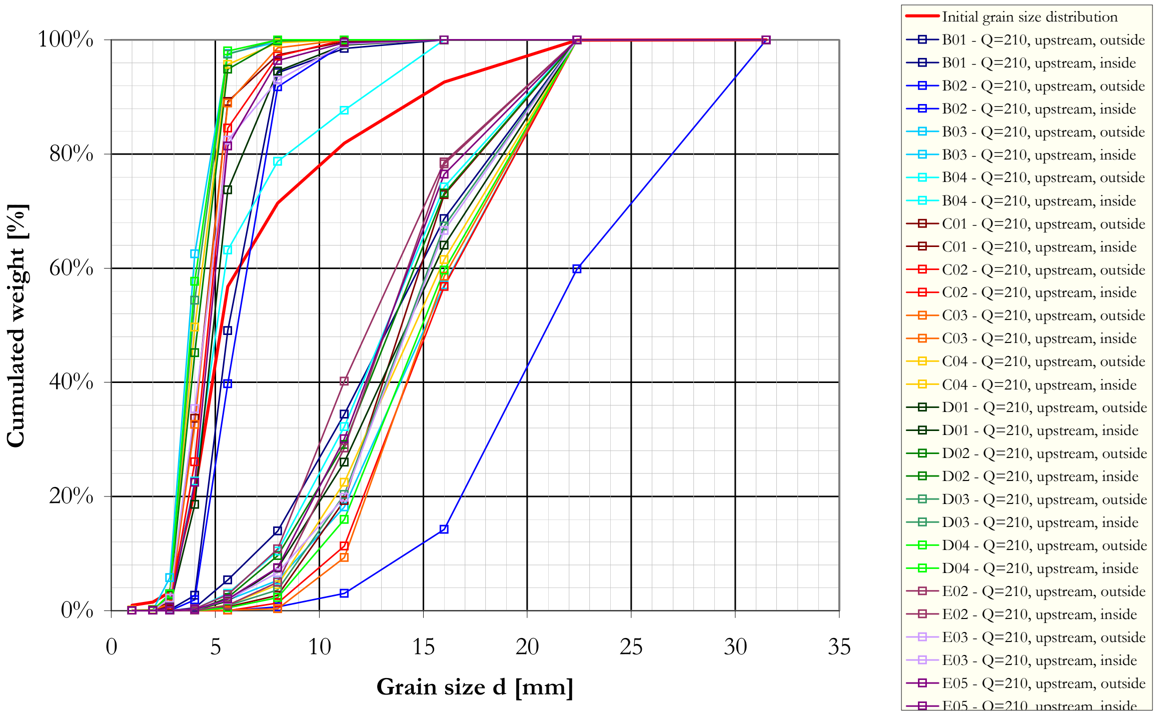


Figure 9.18: Grain size distribution - first scour, Q = 210 l/s, without mr (x01) and with ribs every 4, 2, 1, 8° (x02...x05), e_d = 20mm (cases B-D) and 40mm (E)

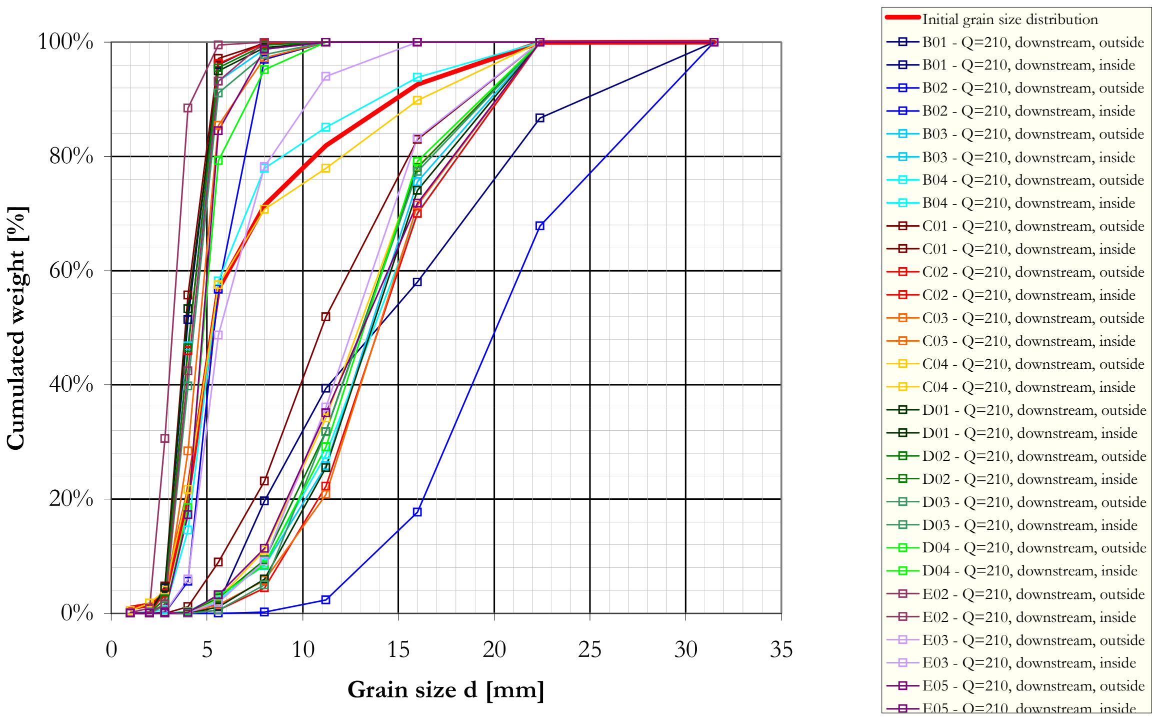


Figure 9.19: Grain size distribution - second scour, Q = 210 l/s, without mr (x01) and with ribs every 4, 2, 1, 8° (x02...x05), e_d = 20mm (cases B-D) and 40mm (E)

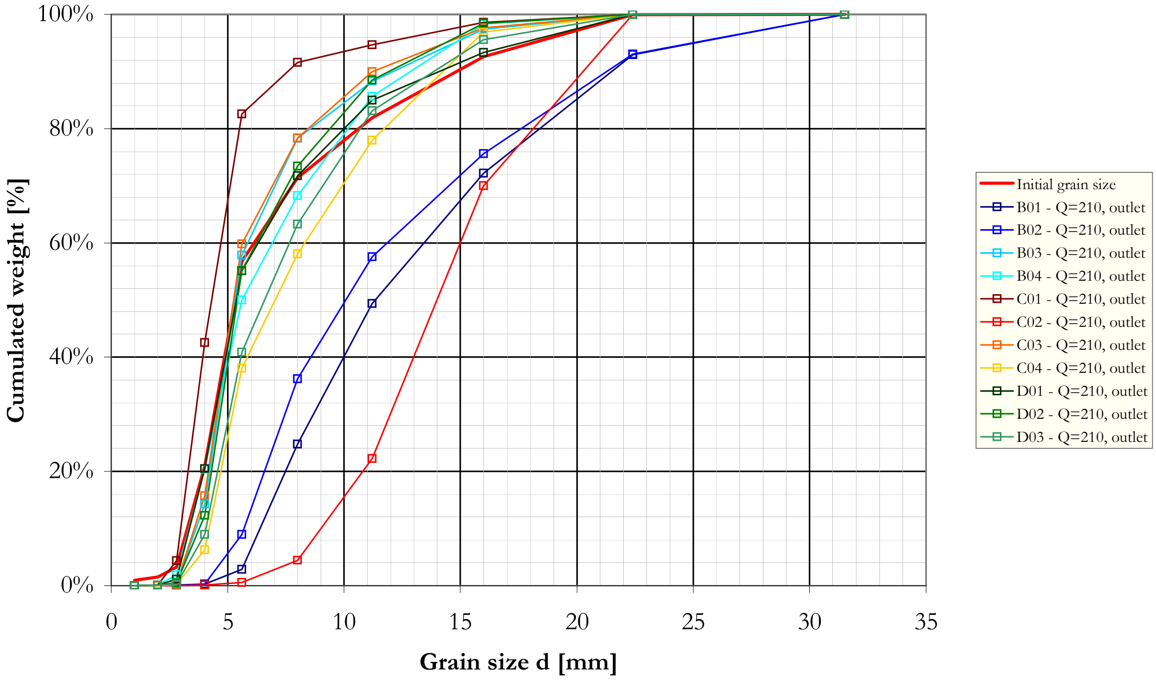
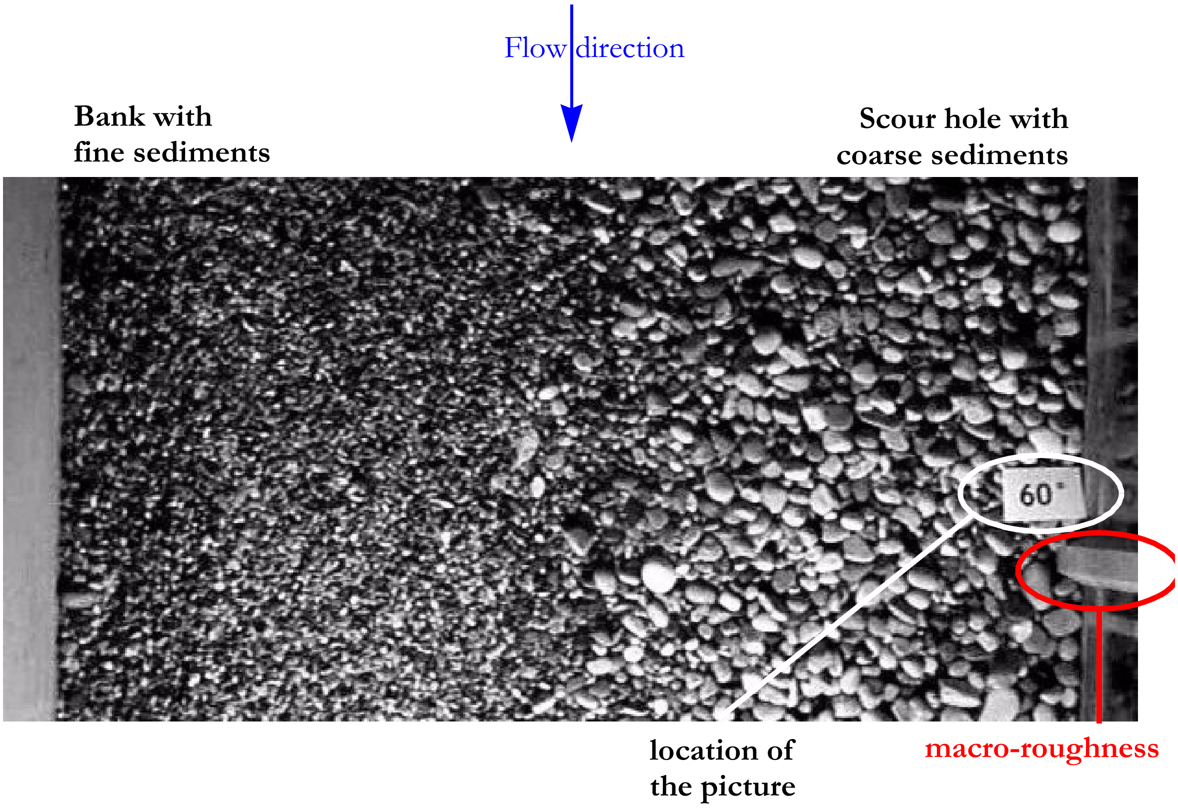


Figure 9.20: Grain size distribution - samples at the outlet, Q = 210 l/s, without mr (x01) and with ribs every 4, 2, 1, 8° (x02...x05), e_d *= 20mm (cases B-D) and 40mm (E)*

APPENDIX 10

GRAIN SIZE DISTRIBUTION - PICTURES OF THE BED

This Appendix gives the final water surface compared to a horizontal average surface over the whole channel (average of all data points).



Additional information can be found in the report in Chapter 5.3.1 and 6.5.

10.1 Channel slope S_0 = 0.35%, Q = 150 l/s, e_d = 20 mm

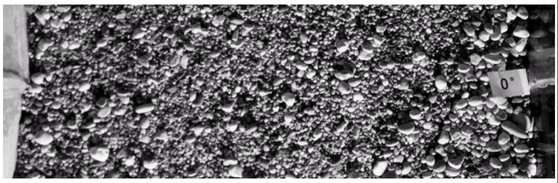
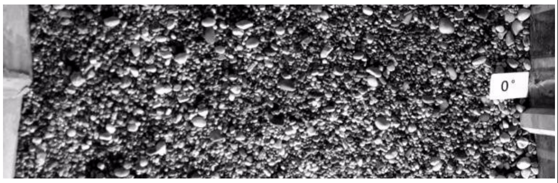
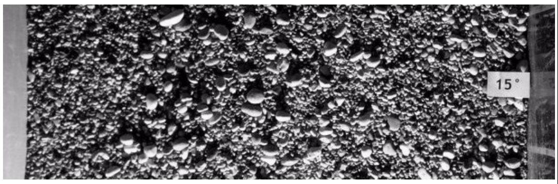
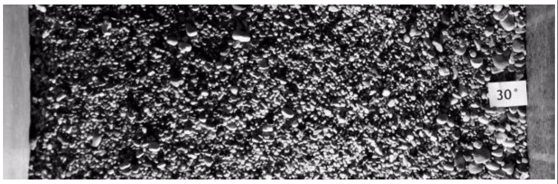
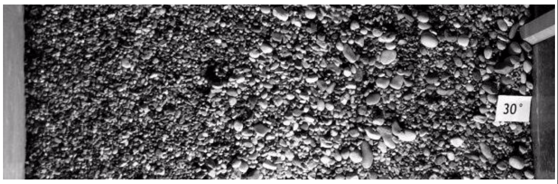
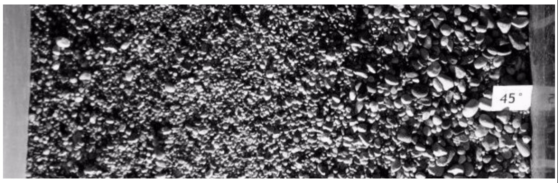
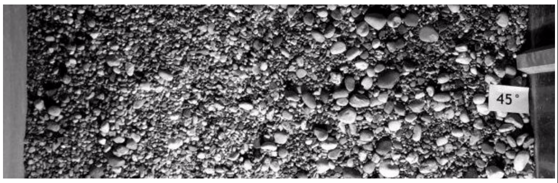
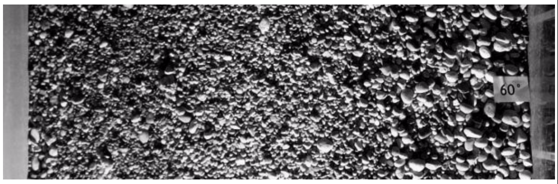
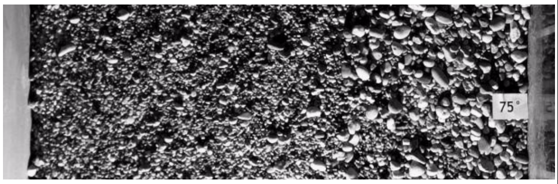
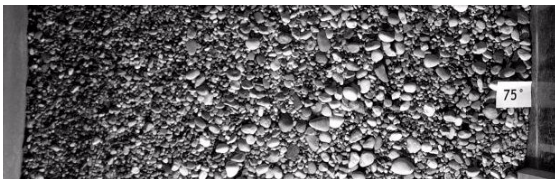
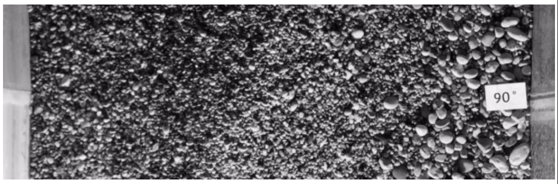
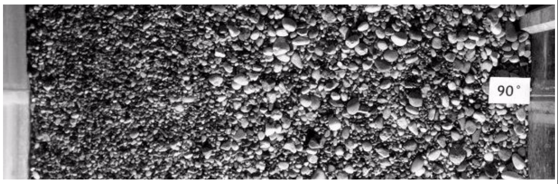
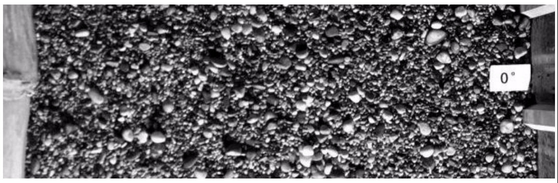
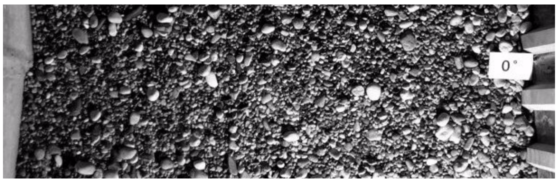
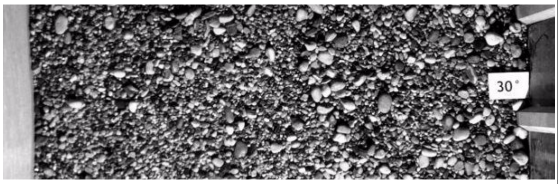
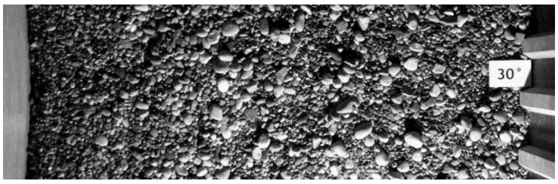
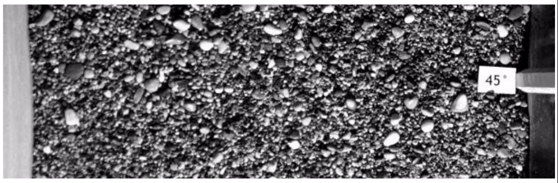
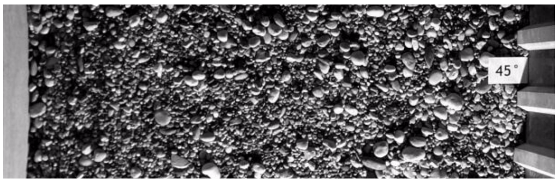
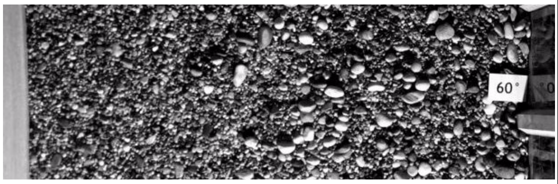
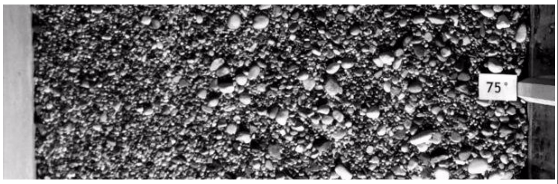
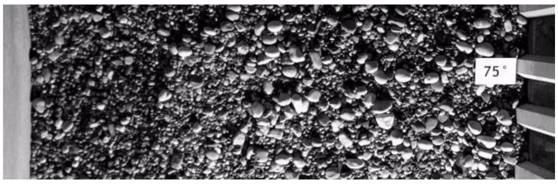
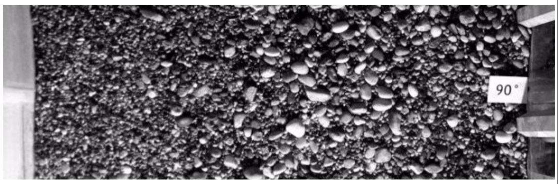
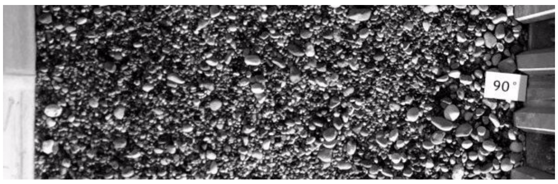
POS. [°]	WITHOUT MR	WITH MR SPACING 4°
0°		
15°		
30°		
45°		
60°		
75°		
90°		

Table 10.1: Pictures of the grain size distribution - S_0 = 0.35%; Q = 150 l/s; e_d = 20 mm

WITH MR SPACING 2°	WITH MR SPACING 1°
	
	
	
	
	
	
	

10.2 Channel slope S_0 = 0.35%, Q = 180 l/s, e_d = 20 mm

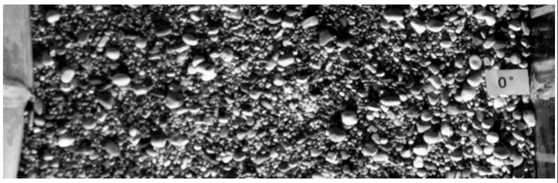
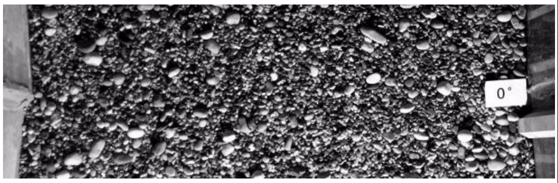
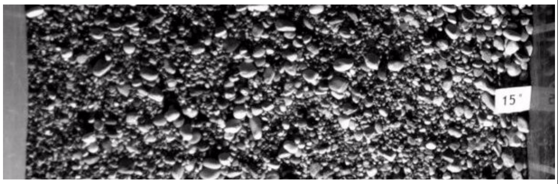
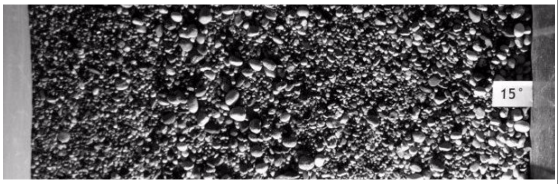
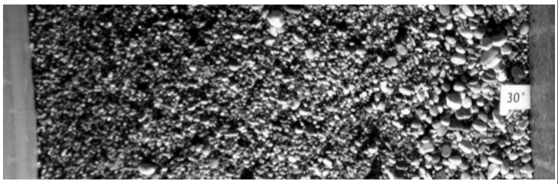
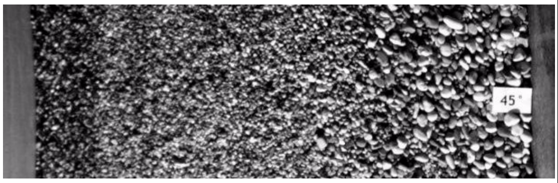
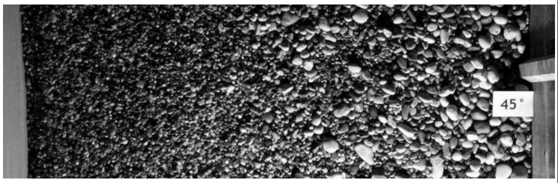
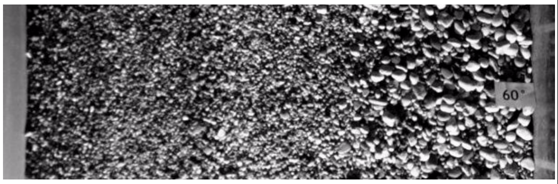
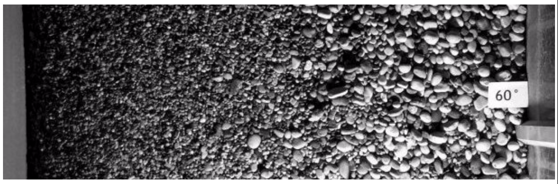
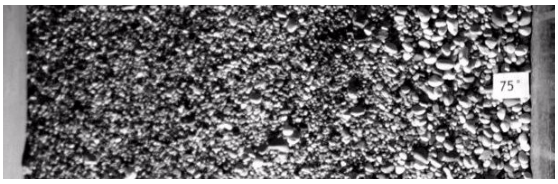
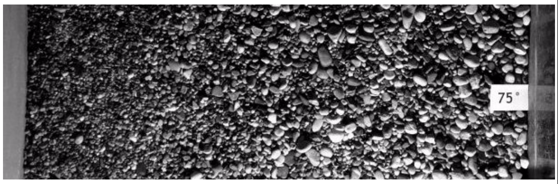
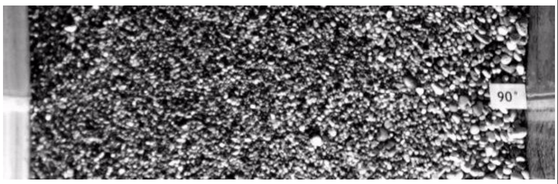
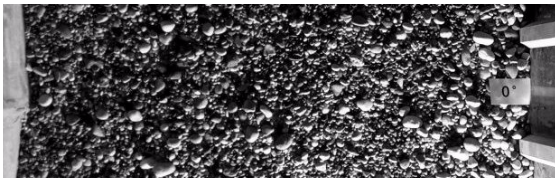
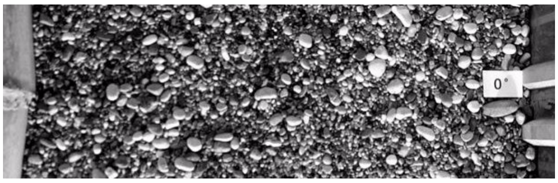
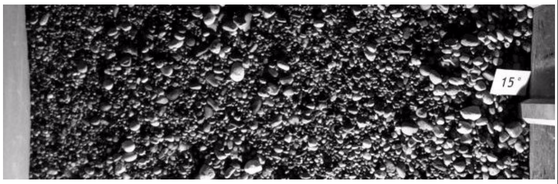
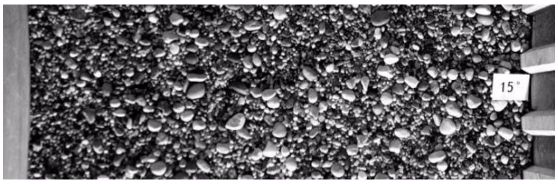
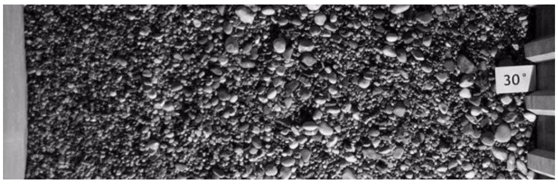
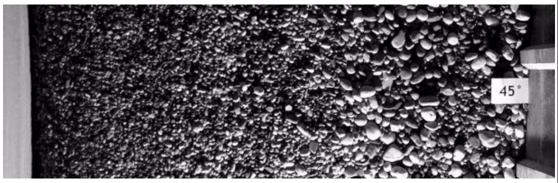
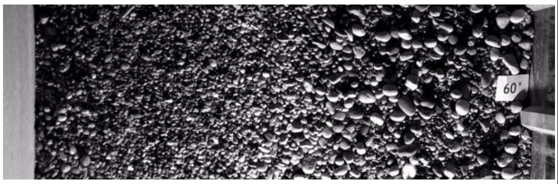
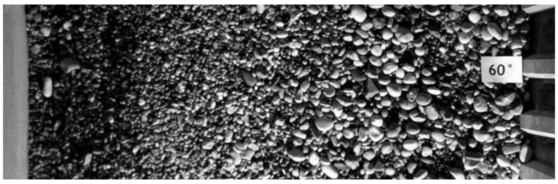
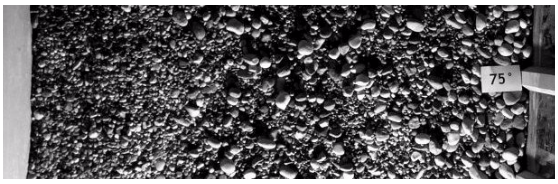
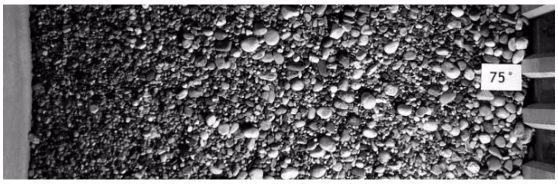
Pos. [°]	without MR	with MR spacing 4°
0°		
15°		
30°		
45°		
60°		
75°		
90°		

Table 10.2: Pictures of the grain size distribution - S_0 = 0.35%; Q = 180 l/s; e_d = 20 mm

WITH MR SPACING 2°	WITH MR SPACING 1°
	
	
	
	
	
	
	

10.3 Channel slope S_0 = 0.35%, Q = 210 l/s, e_d = 20 mm

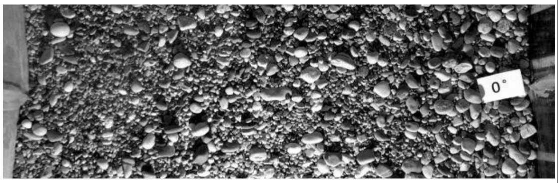
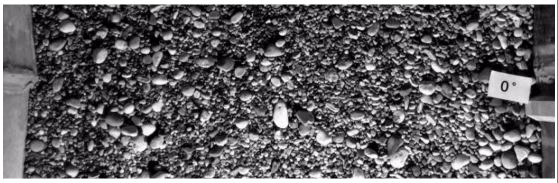
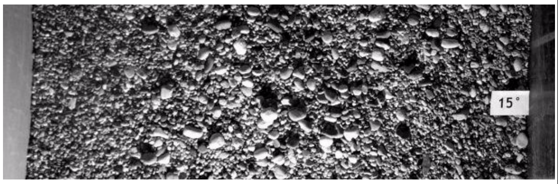
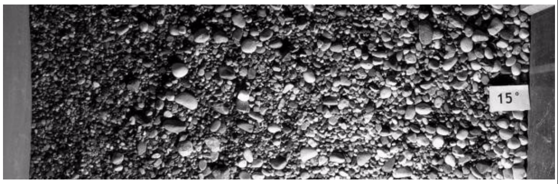
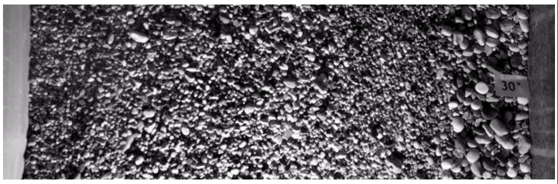
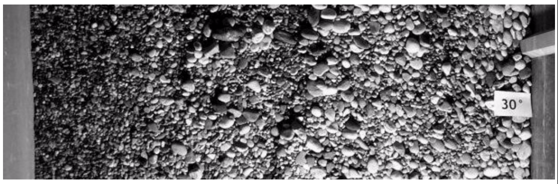
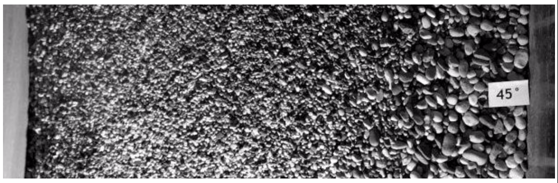
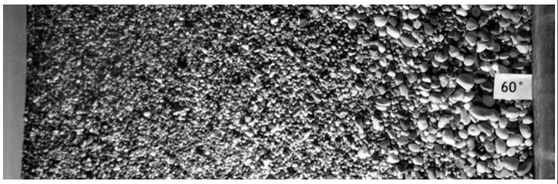
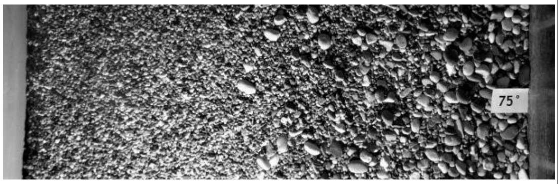
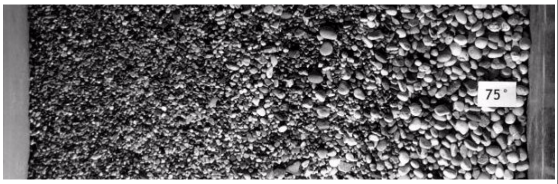
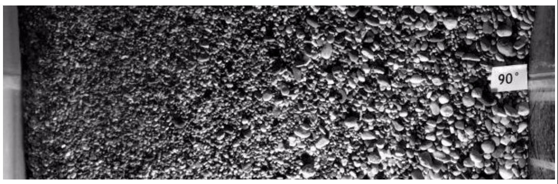
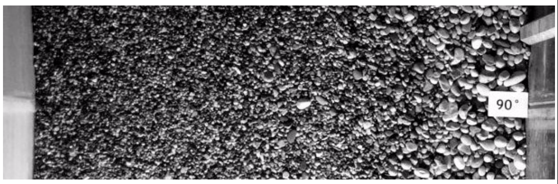
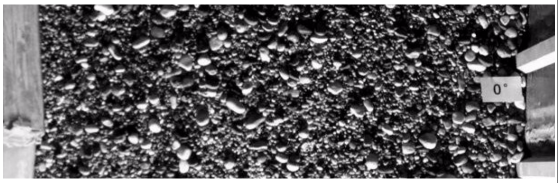
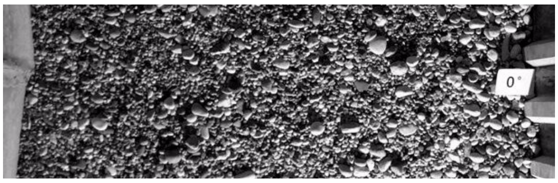
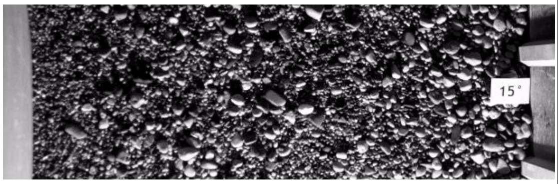
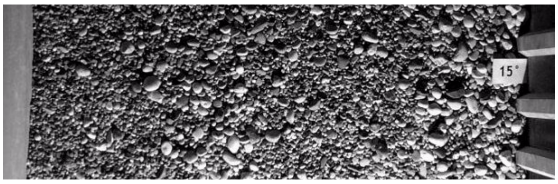
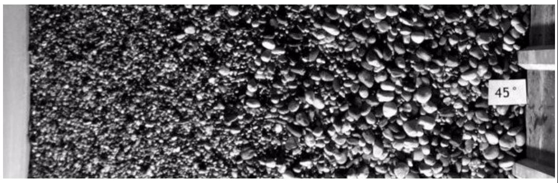
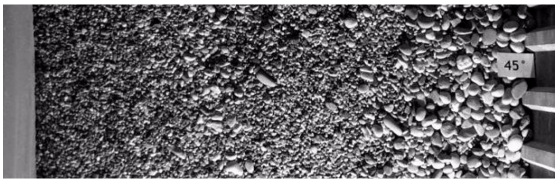
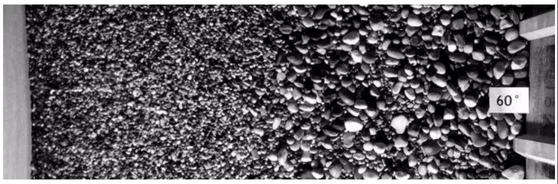
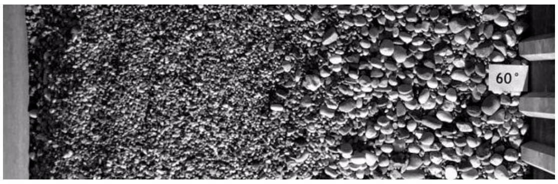
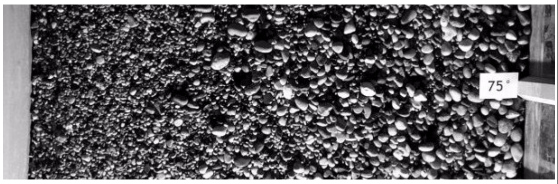
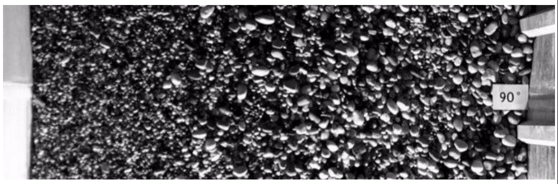
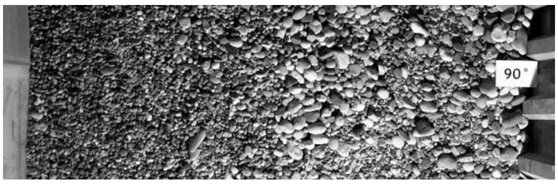
POS. [°]	WITHOUT MR	WITH MR SPACING 4°
0°		
15°		
30°		
45°		
60°		
75°		
90°		

Table 10.3: Pictures of the grain size distribution - S_0 = 0.35%; Q = 210 l/s; e_d = 20 mm

WITH MR SPACING 2°	WITH MR SPACING 1°
	
	
	
	
	
	
	

10.4 Channel slope S_0 = 0.50%, Q = 150 l/s, e_d = 20 mm

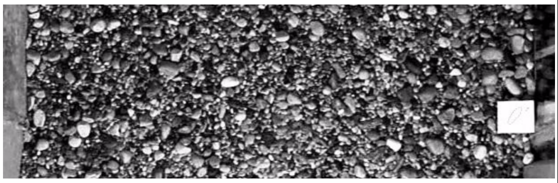
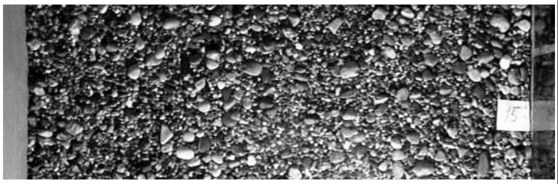
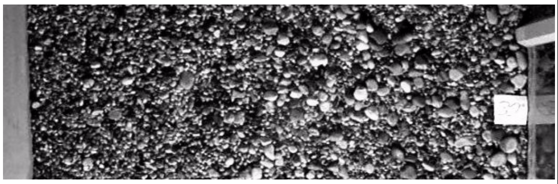
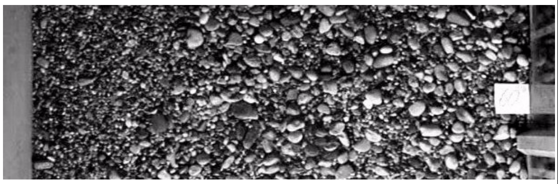
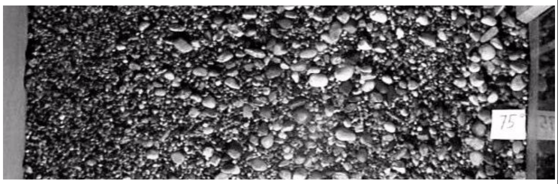
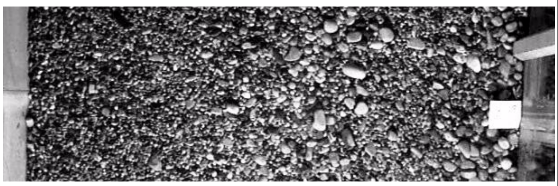
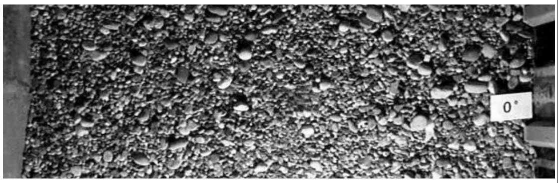
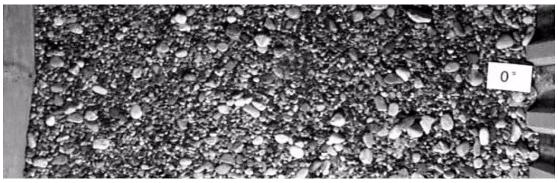
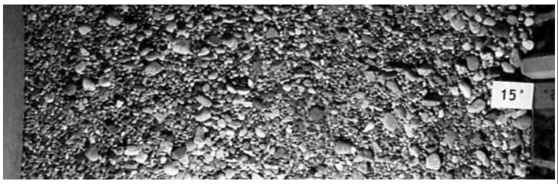
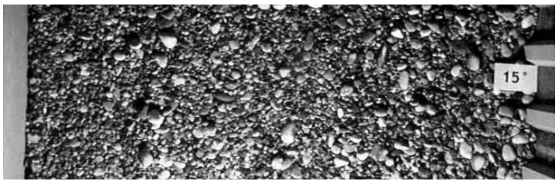
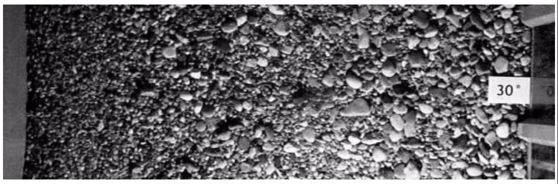
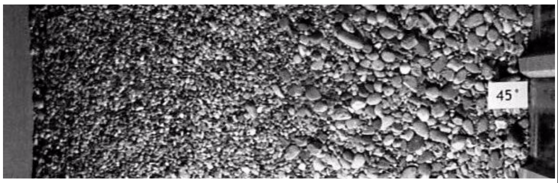
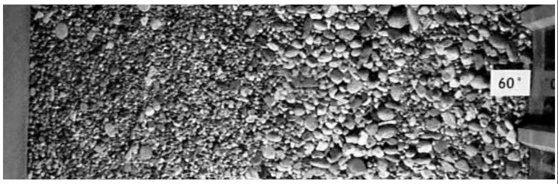
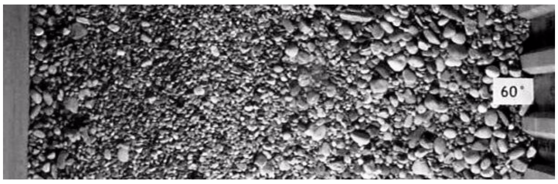
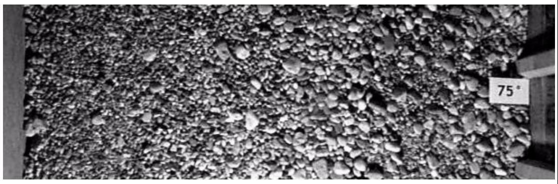
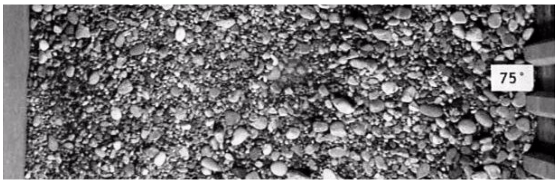
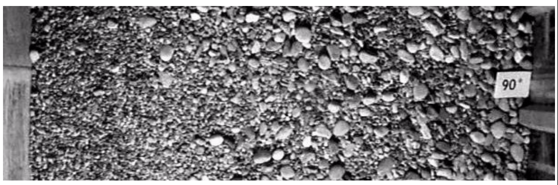
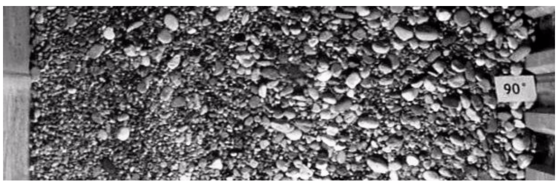
POS. [°]	WITHOUT MR	WITH MR SPACING 4°
0°		
15°		
30°		
45°		
60°		
75°		
90°		

Table 10.4: Pictures of the grain size distribution - S_0 = 0.50%; Q = 150 l/s; e_d = 20 mm

WITH MR SPACING 2°	WITH MR SPACING 1°
	
	
	
	
	
	
	

10.5 Channel slope S_0 = 0.50%, Q = 180 l/s, e_d = 20 mm

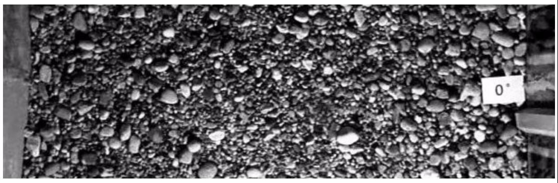
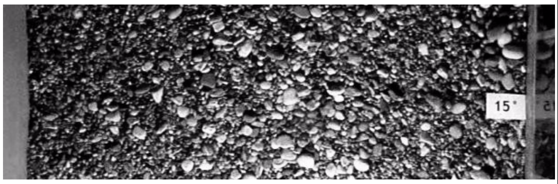
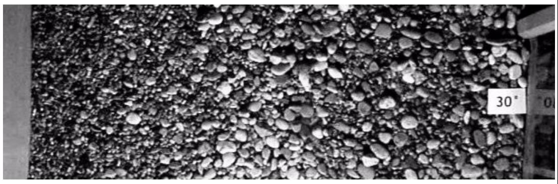
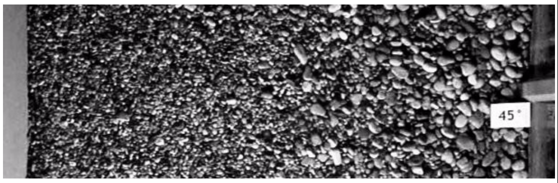
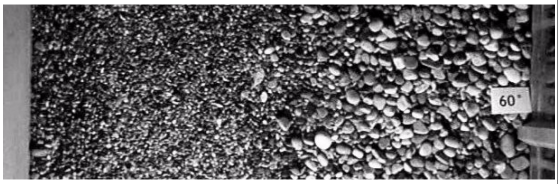
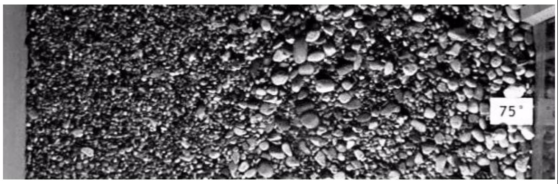
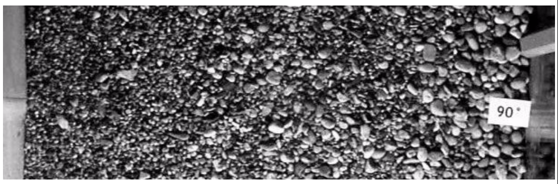
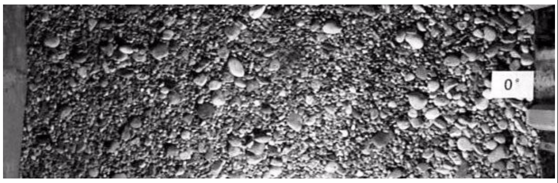
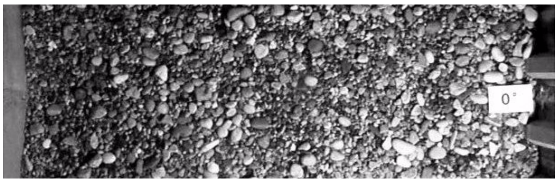
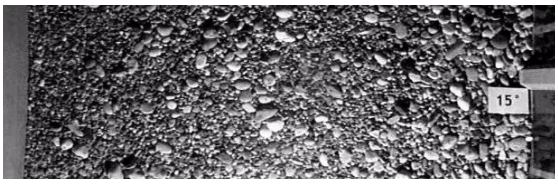
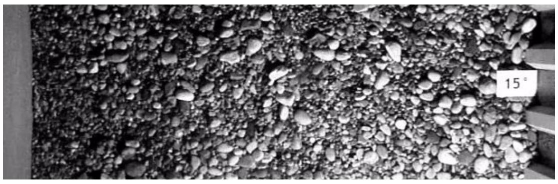
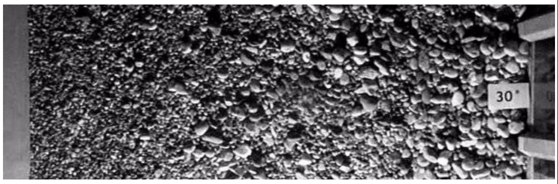
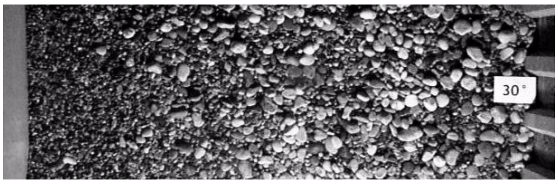
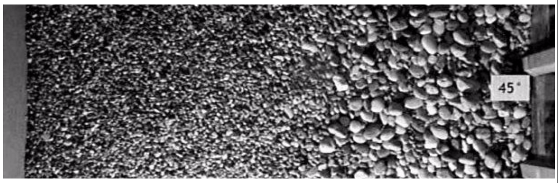
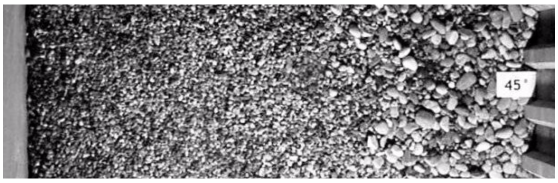
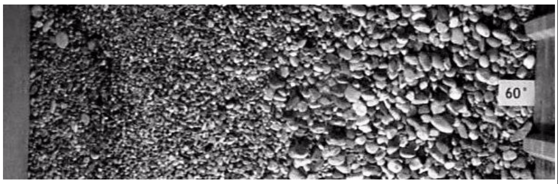
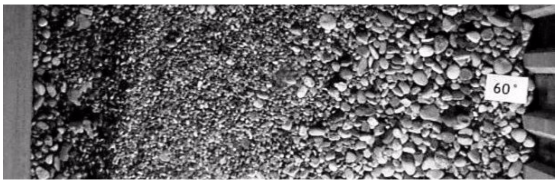
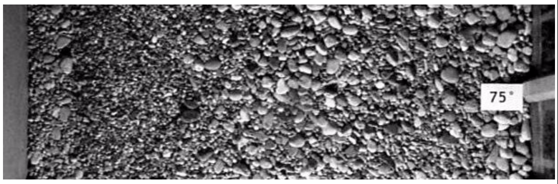
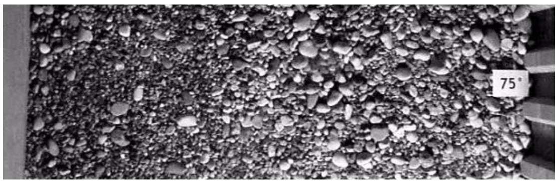
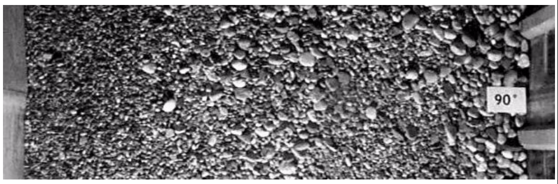
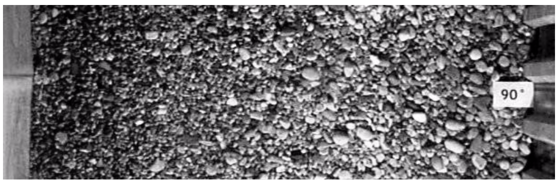
POS. [°]	WITHOUT MR	WITH MR SPACING 4°
0°		
15°		
30°		
45°		
60°		
75°		
90°		

Table 10.5: Pictures of the grain size distribution - S_0 = 0.50%; Q = 180 l/s; e_d = 20 mm

WITH MR SPACING 2°	WITH MR SPACING 1°
	
	
	
	
	
	
	

10.6 Channel slope S_0 = 0.50%, Q = 210 l/s, e_d = 20 mm

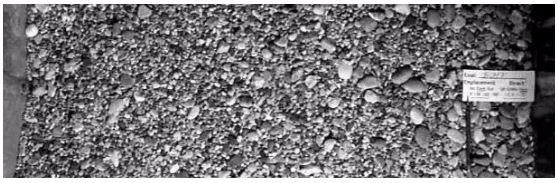
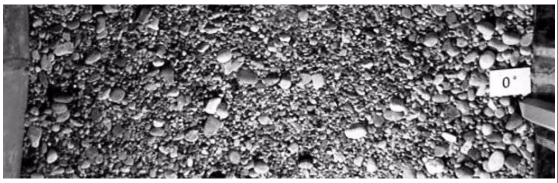
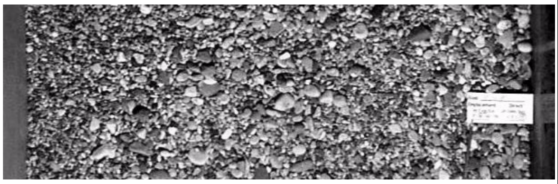
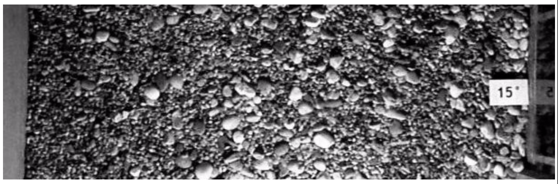
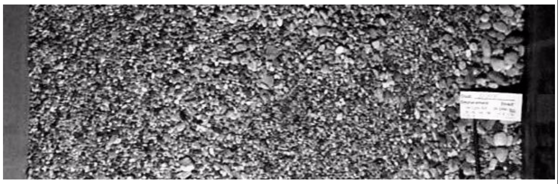
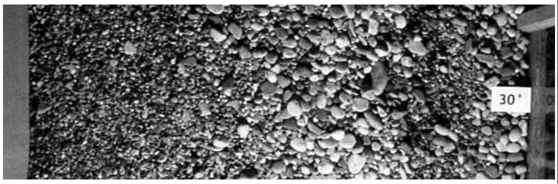
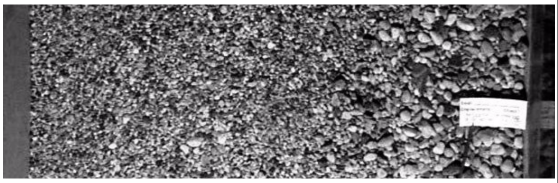
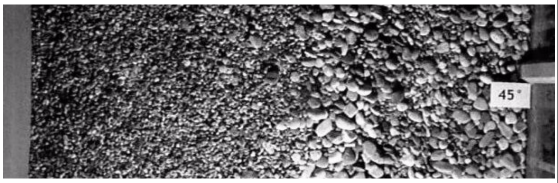
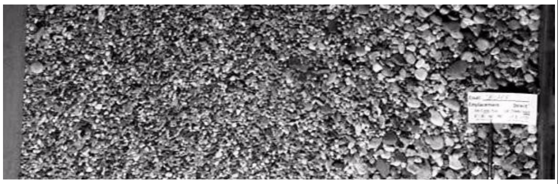
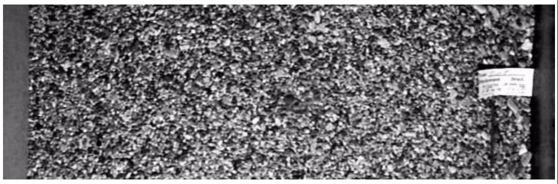
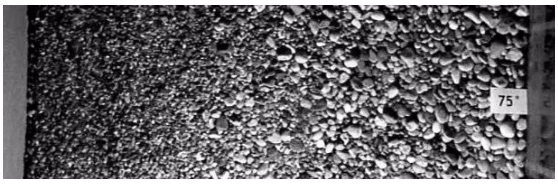
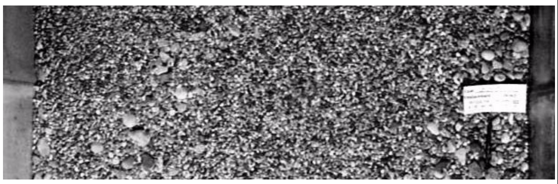
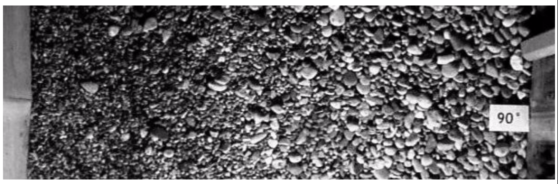
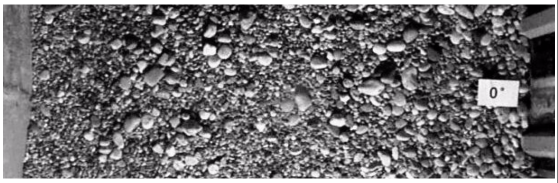
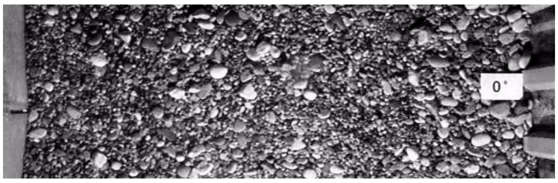
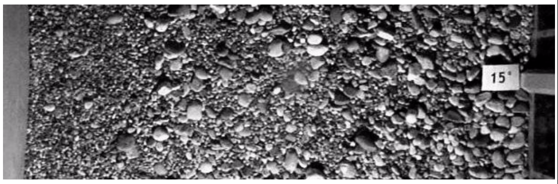
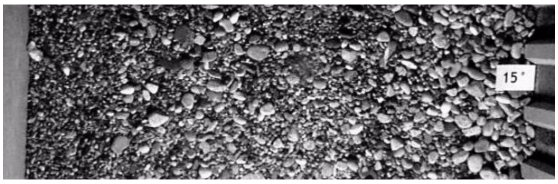
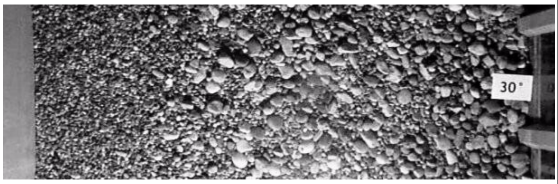
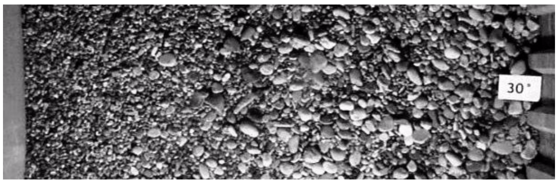
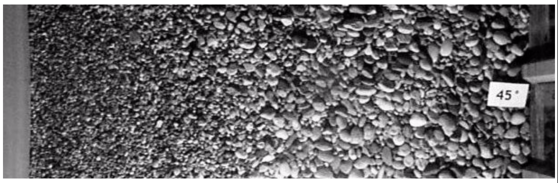
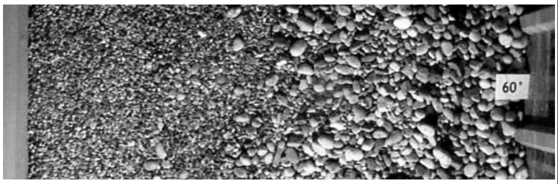
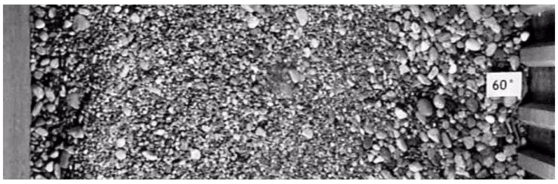
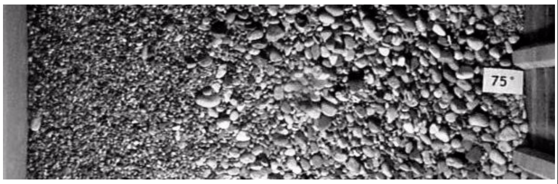
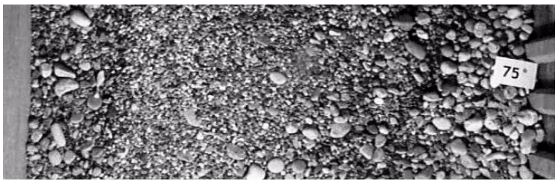
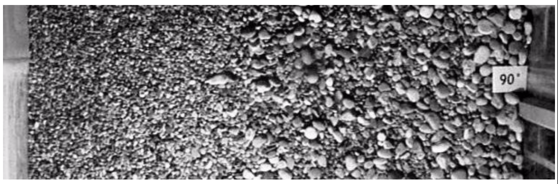
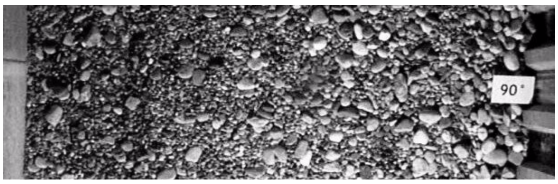
POS. [°]	WITHOUT MR	WITH MR SPACING 4°
0°		
15°		
30°		
45°		
60°		
75°		
90°		

Table 10.6: Pictures of the grain size distribution - S_0 = 0.50%; Q = 210 l/s; e_d = 20 mm

WITH MR SPACING 2°	WITH MR SPACING 1°
	
	
	
	
	
	
	

10.7 Channel slope S_0 = 0.75%, Q = 150 l/s, e_d = 20 mm

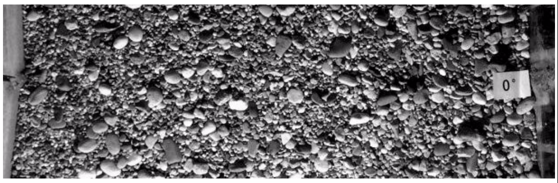
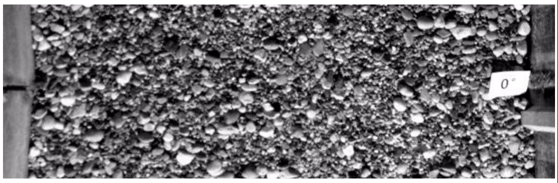
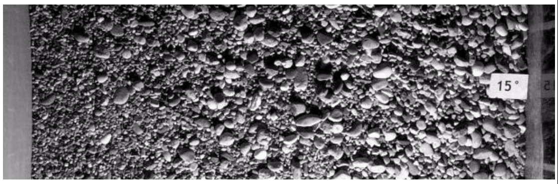
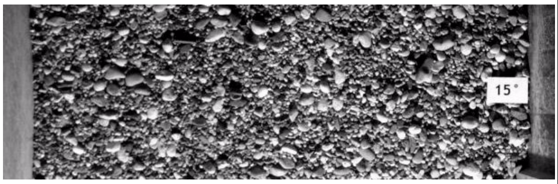
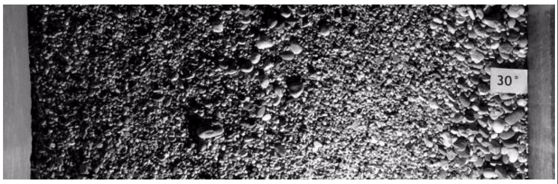
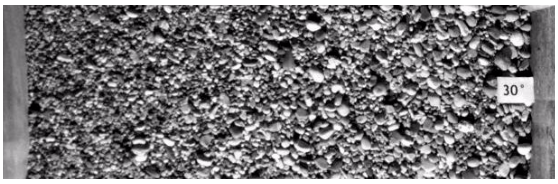
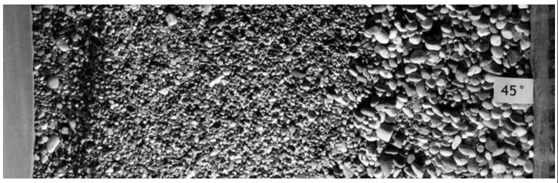
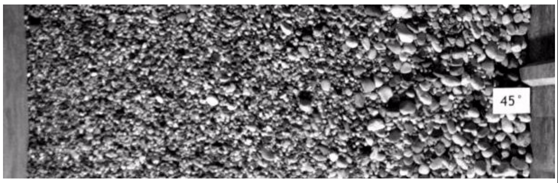
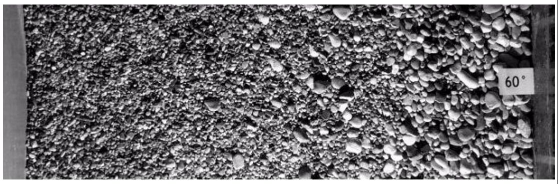
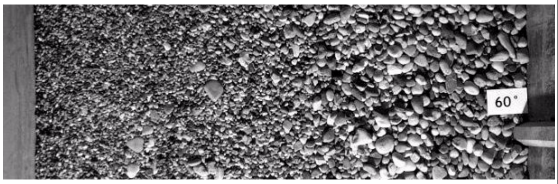
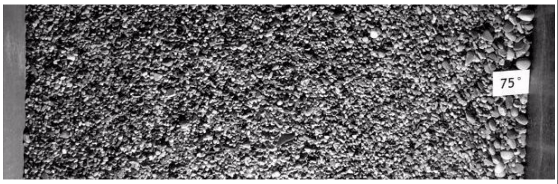
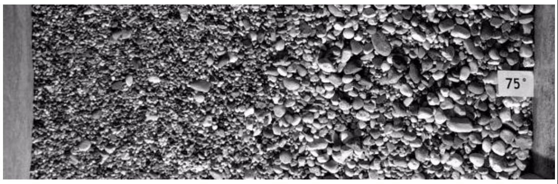
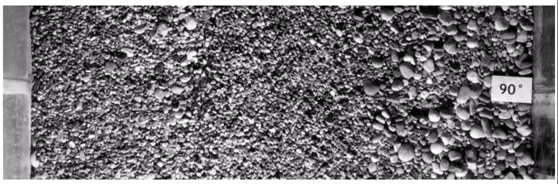
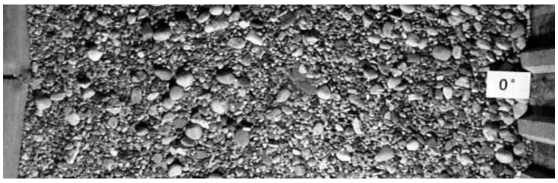
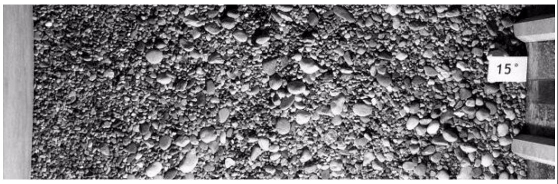
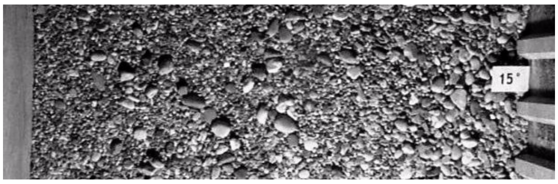
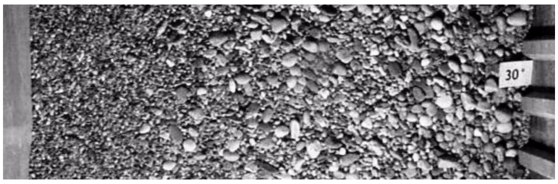
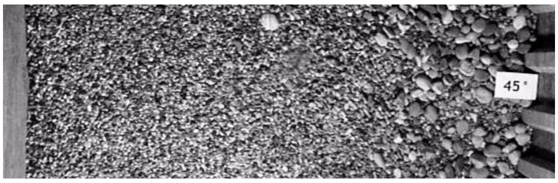
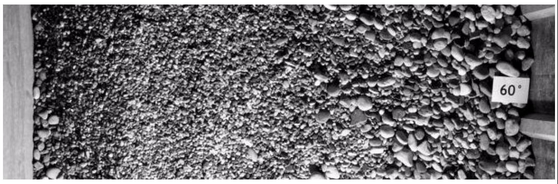
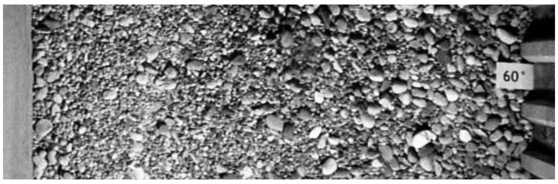
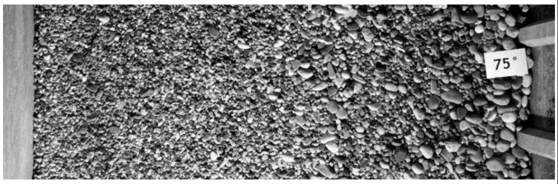
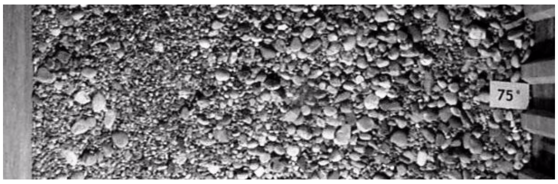
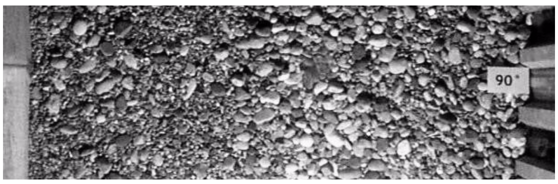
POS. [°]	WITHOUT MR	WITH MR SPACING 4°
0°		
15°		
30°		
45°		
60°		
75°		
90°		

Table 10.7: Pictures of the grain size distribution - S_0 = 0.75%; Q = 150 l/s; e_d = 20 mm

WITH MR SPACING 2°	WITH MR SPACING 1°
	
	
	
	
	
	
	

10.8 Channel slope S_0 = 0.75%, Q = 180 l/s, e_d = 20 mm

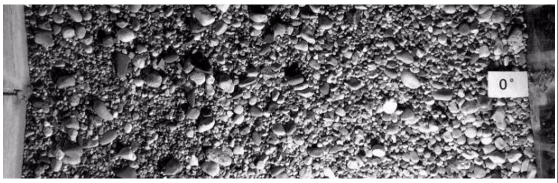
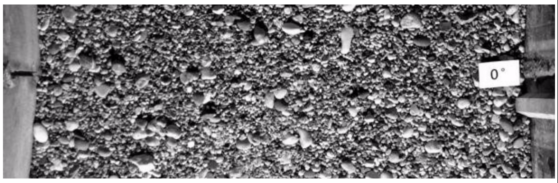
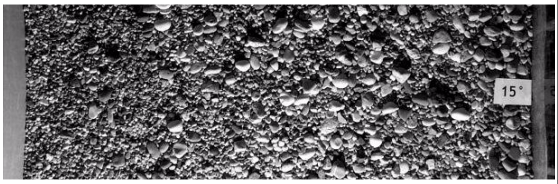
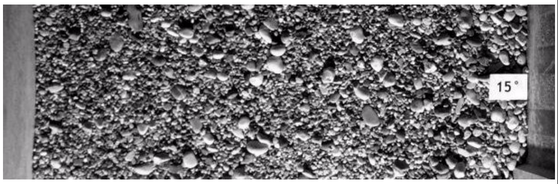
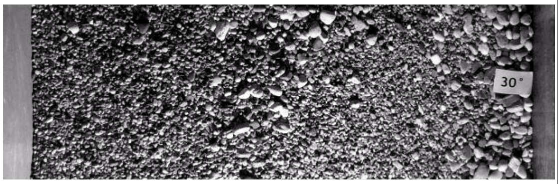
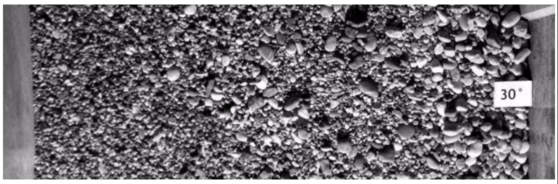
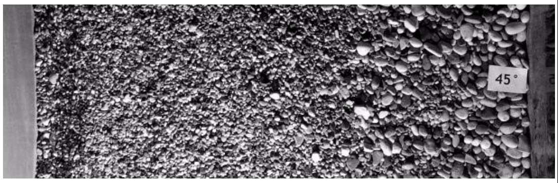
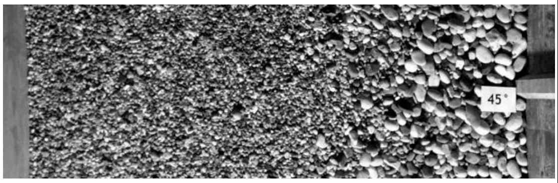
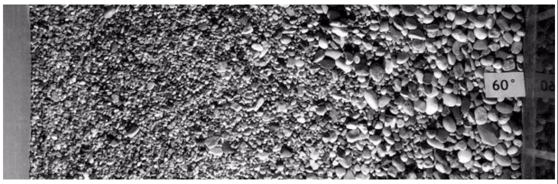
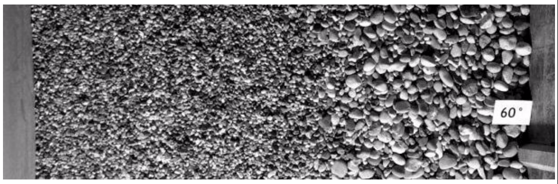
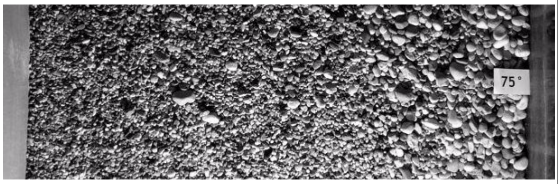
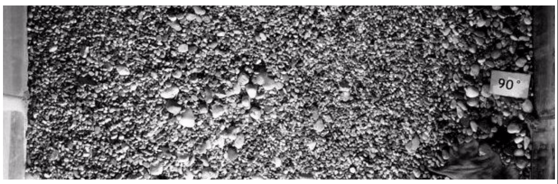
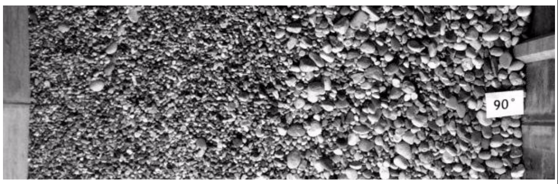
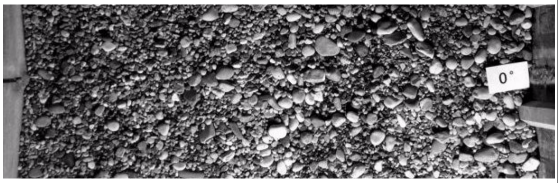
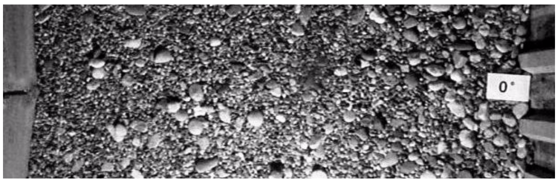
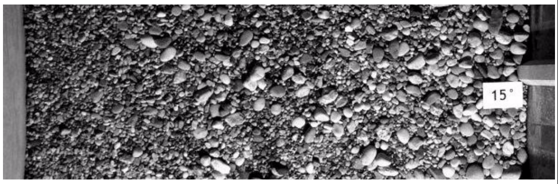
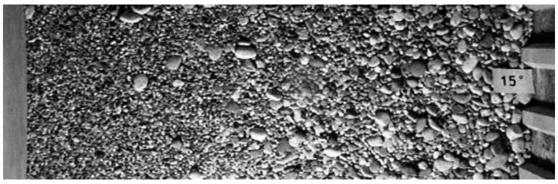
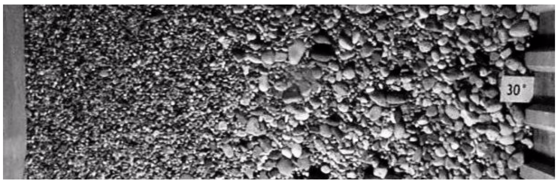
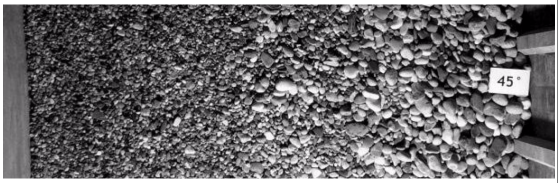
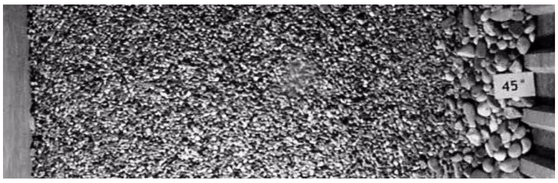
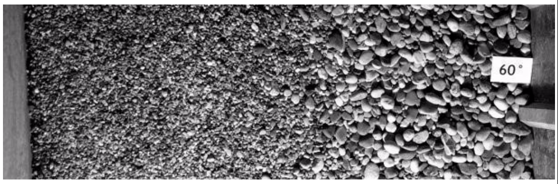
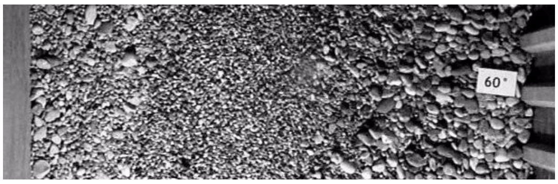
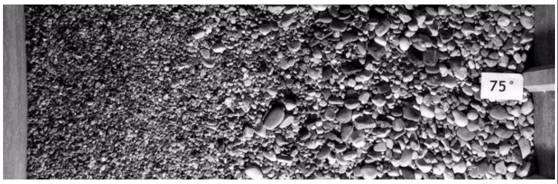
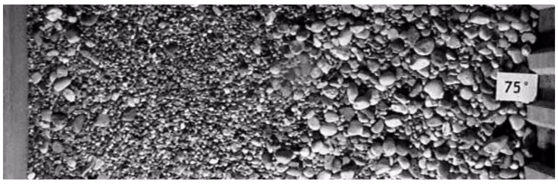
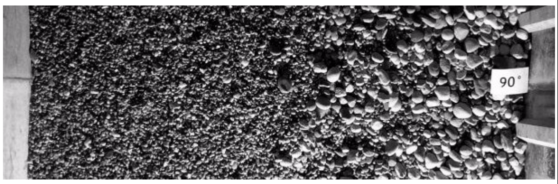
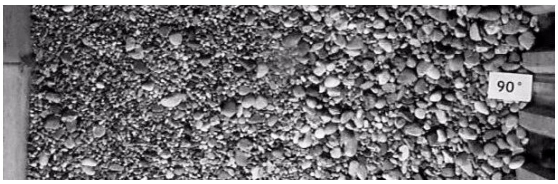
Pos. [°]	without MR	with MR spacing 4°
0°		
15°		
30°		
45°		
60°		
75°		
90°		

Table 10.8: Pictures of the grain size distribution - S_0 = 0.75%; Q = 180 l/s; e_d = 20 mm

WITH MR SPACING 2°	WITH MR SPACING 1°
	
	
	
	
	
	
	

10.9 Channel slope S_0 = 0.75%, Q = 210 l/s, e_d = 20 mm

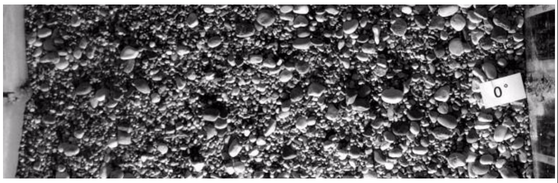
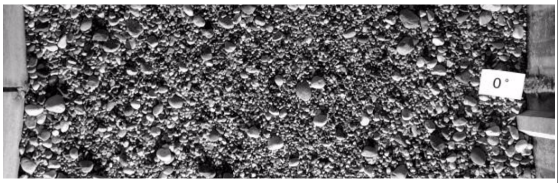
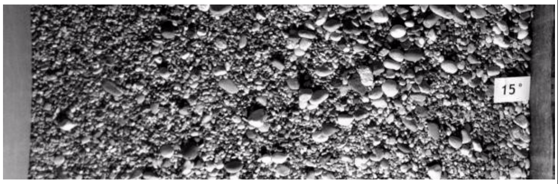
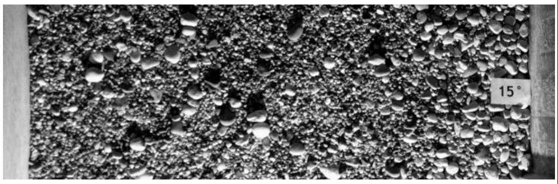
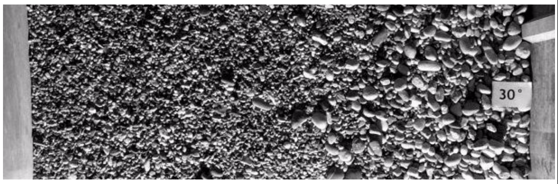
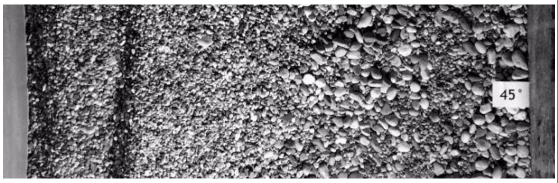
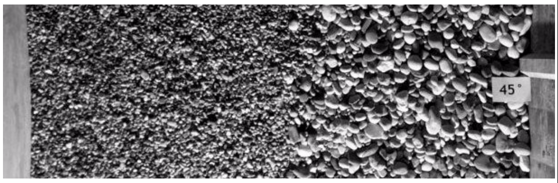
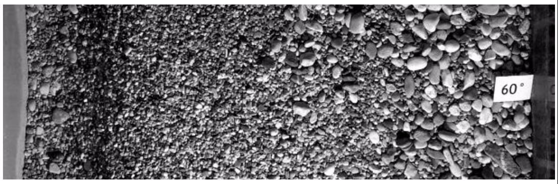
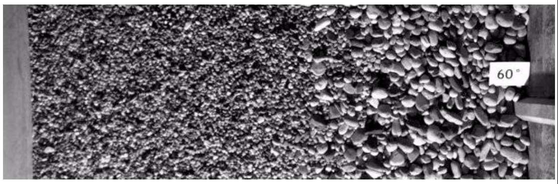
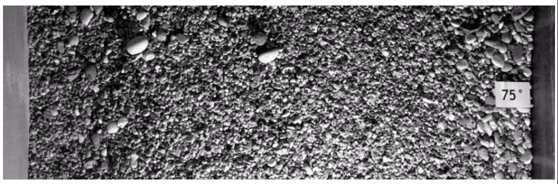
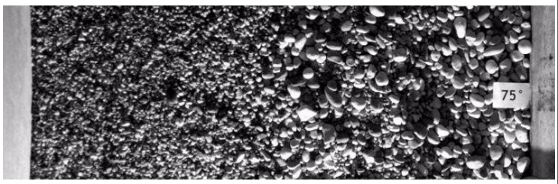
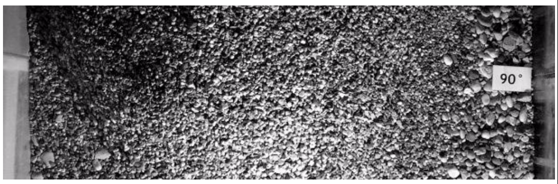
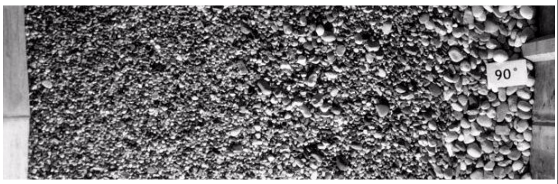
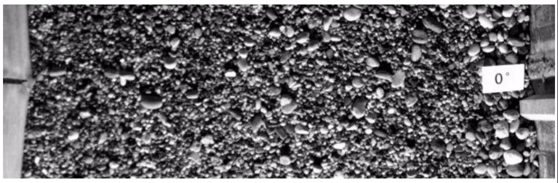
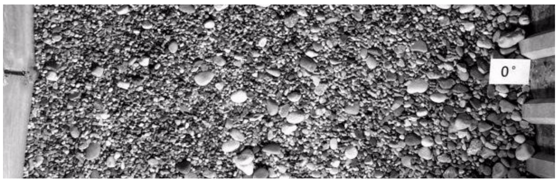
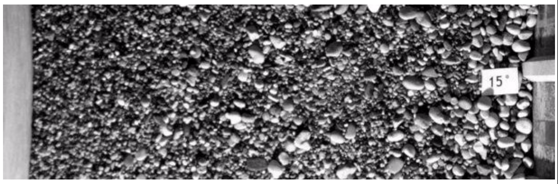
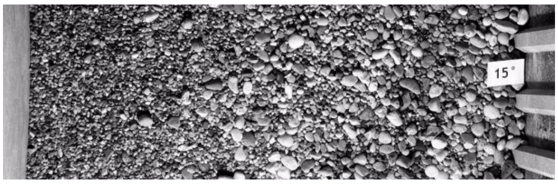
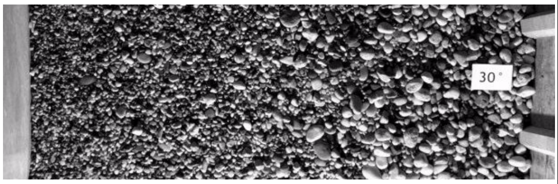
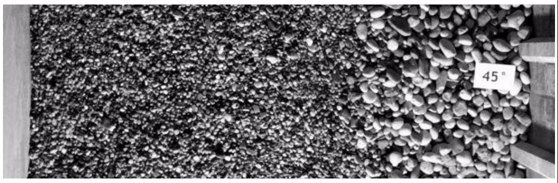
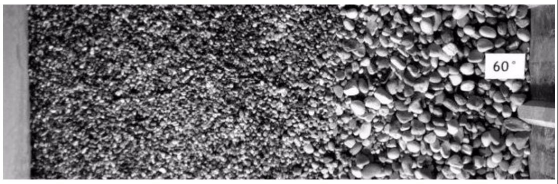
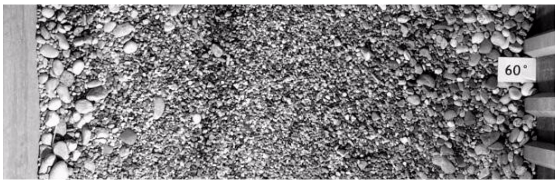
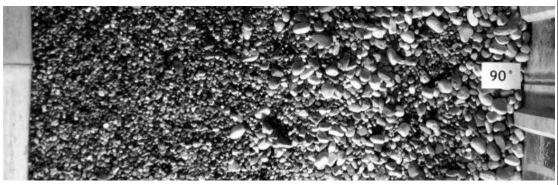
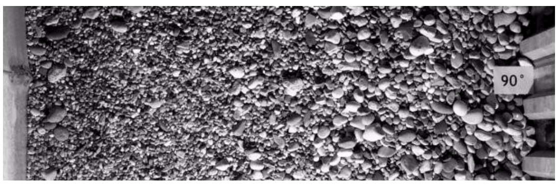
Pos. [°]	without MR	with MR spacing 4°
0°		
15°		
30°		
45°		
60°		
75°		
90°		

Table 10.9: Pictures of the grain size distribution - S_0 = 0.75%; Q = 210 l/s; e_d = 20 mm

WITH MR SPACING 2°	WITH MR SPACING 1°
	
	
	
	
	
	
	

10.10 Channel slope S_0 = 0.50%, Q = 150 l/s, e_d = 40 mm

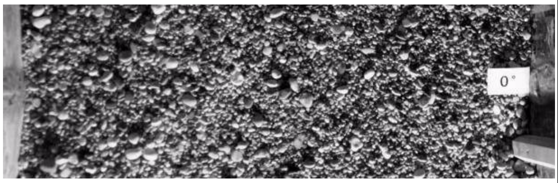
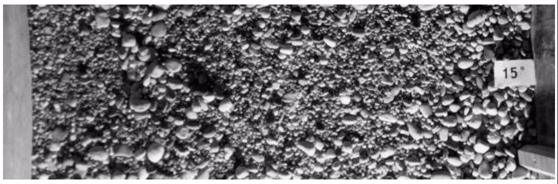
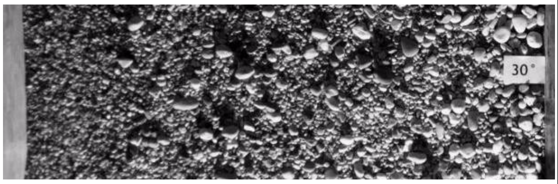
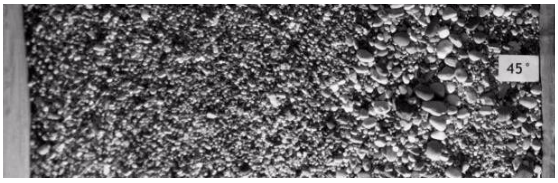
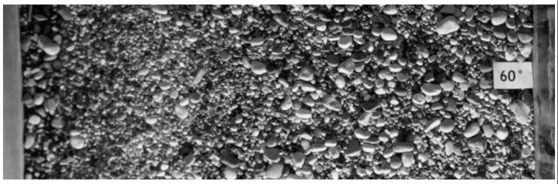
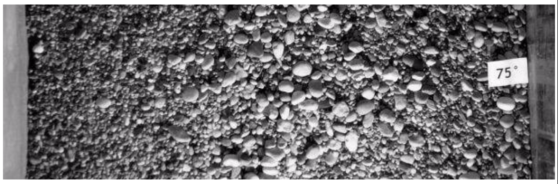
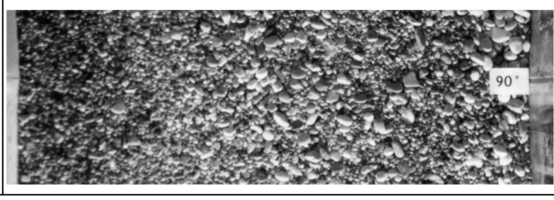
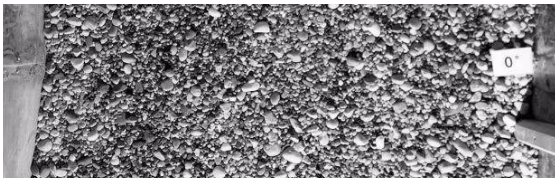
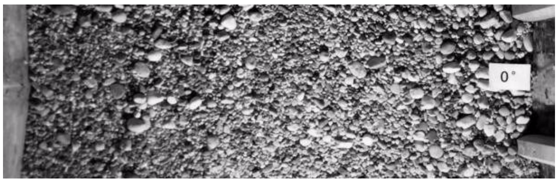
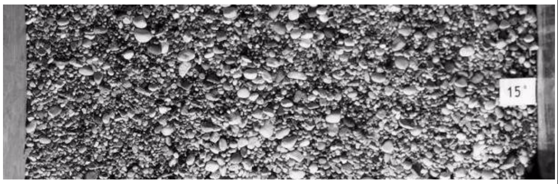
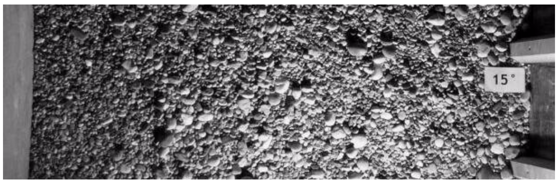
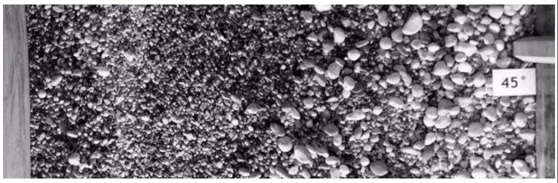
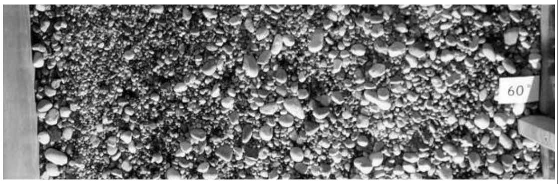
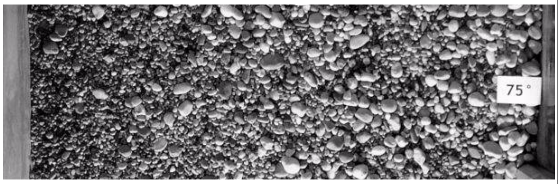
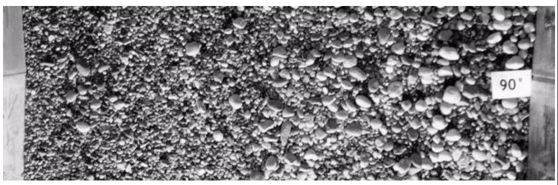
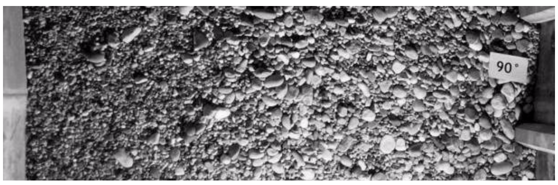
POS. [°]	WITHOUT MR	WITH MR SPACING 8°
0°		
15°		
30°		
45°		
60°		
75°		
90°		

Table 10.10: Pictures of the grain size distribution - S_0 = 0.50%; Q = 150 l/s; e_d = 40 mm

WITH MR SPACING **4°**	WITH MR SPACING **2°**
	
	
	
	
	
	
	

10.11 Channel slope S_0 = 0.50%, Q = 180 l/s, e_d = 40 mm

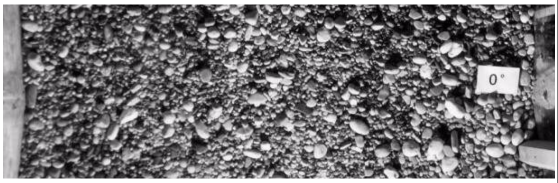
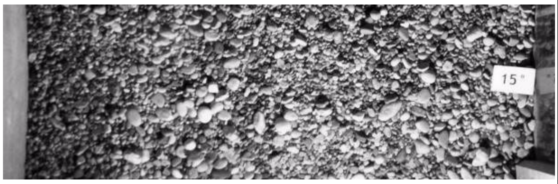
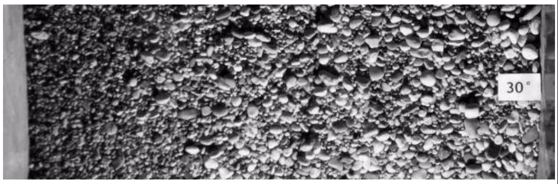
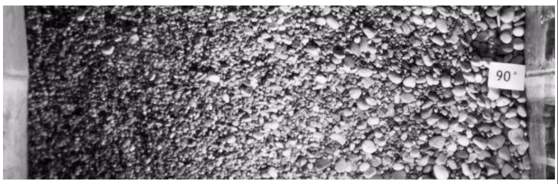
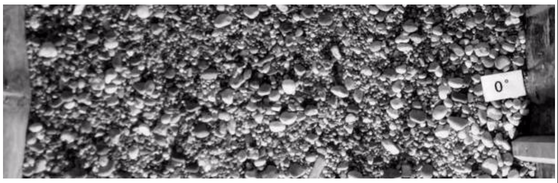
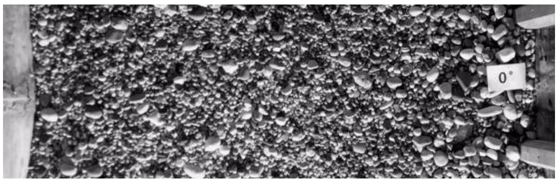
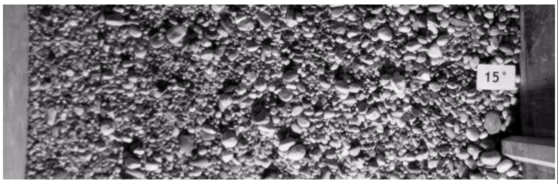
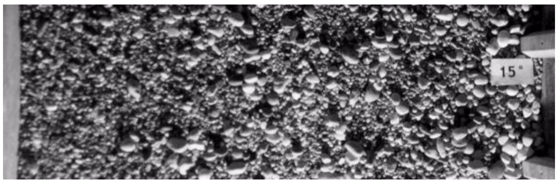
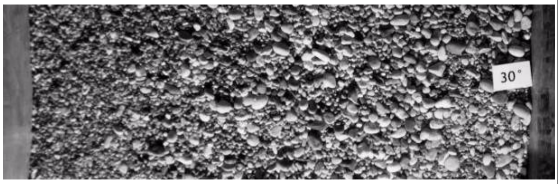
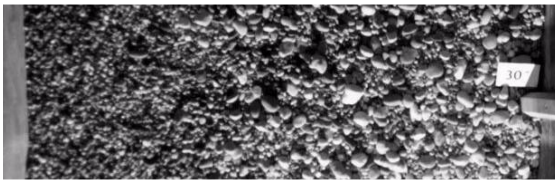
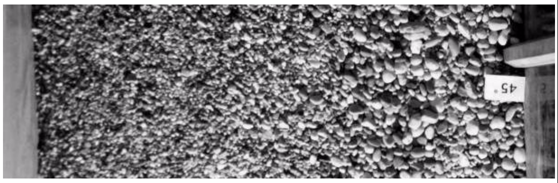
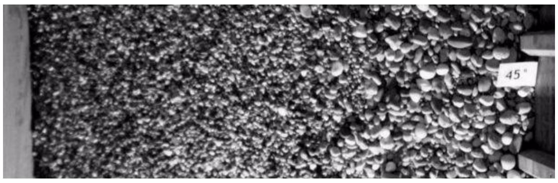
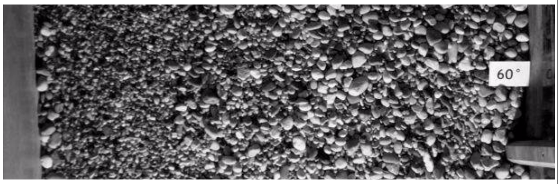
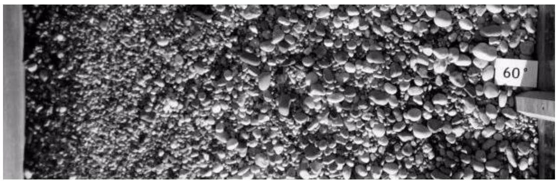
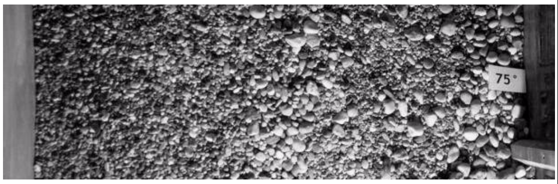
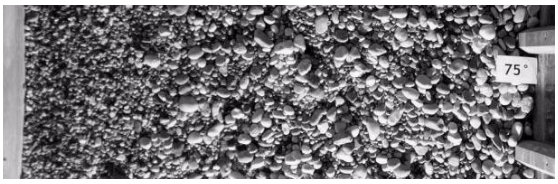
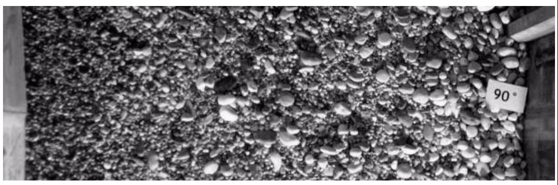
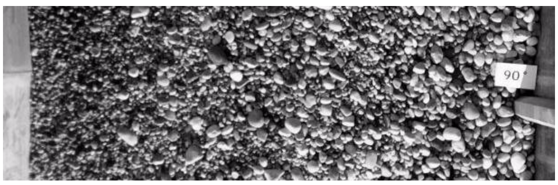
POS. [°]	WITHOUT MR	WITH MR SPACING 8°
0°		
15°		
30°		
45°		
60°		
75°		
90°		

Table 10.11: Pictures of the grain size distribution - S_0 = 0.50%; Q = 180 l/s; e_d = 40 mm

WITH MR SPACING **4°**	WITH MR SPACING **2°**
	
	
	
	
	
	
	

10.12 Channel slope S_0 = 0.50%, Q = 210 l/s, e_d = 40 mm

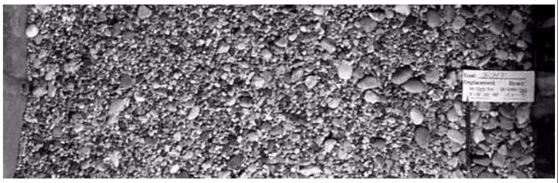
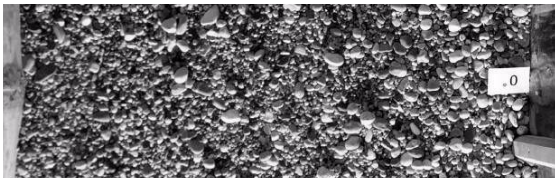
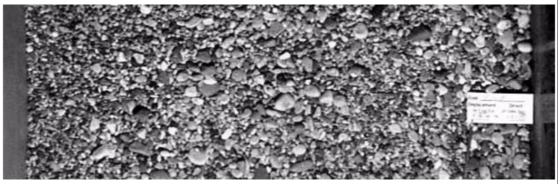
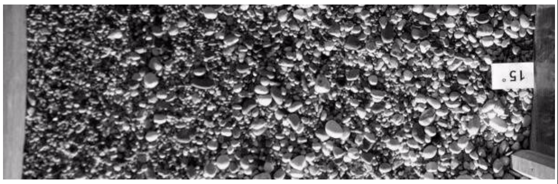
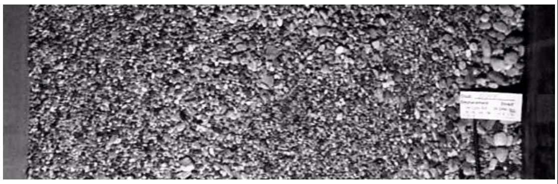
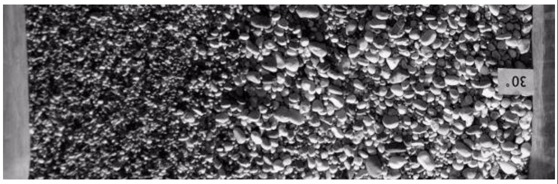
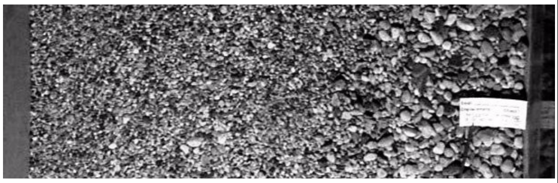
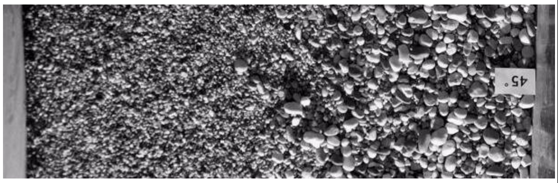
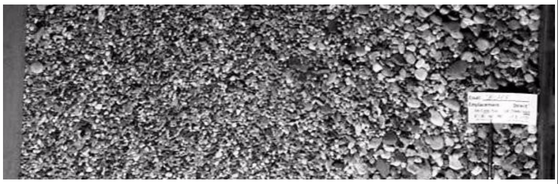
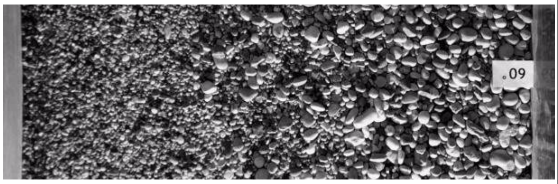
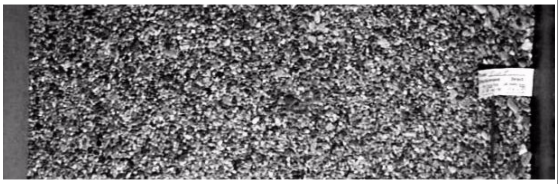
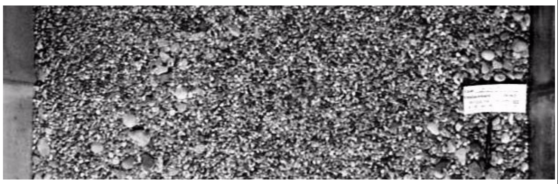
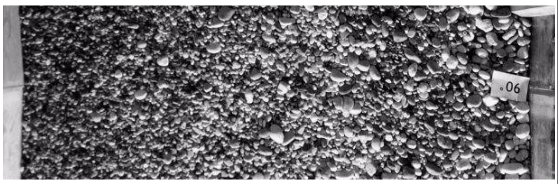
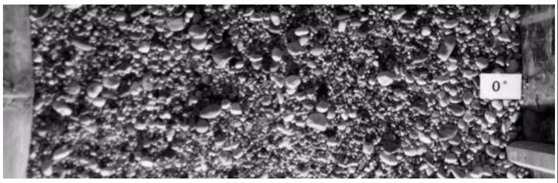
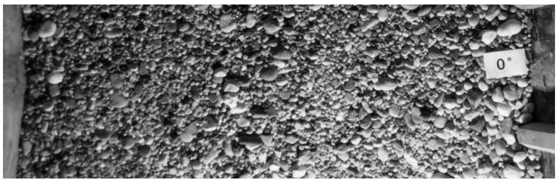
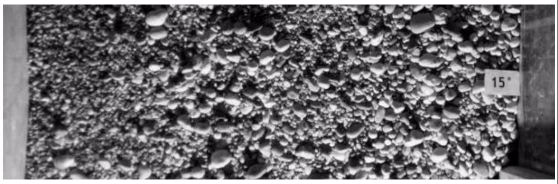
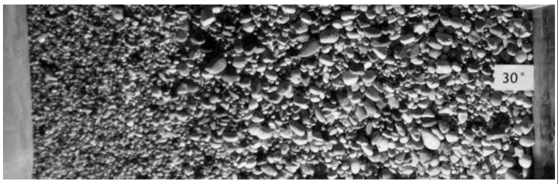
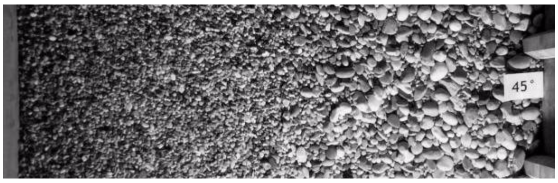
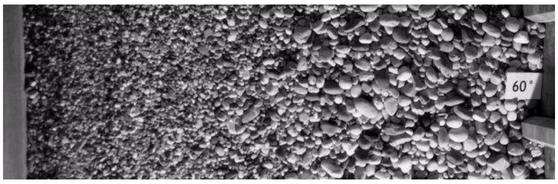
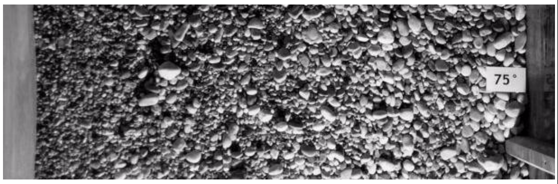
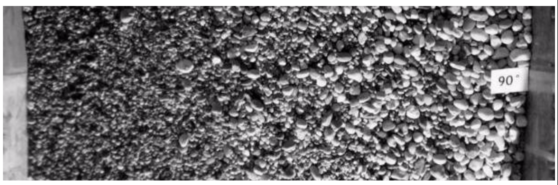
Pos. [°]	without MR copy of A.	with MR spacing 8°
0°		
15°		
30°		
45°		
60°		
75°		
90°		

Table 10.12: Pictures of the grain size distribution - S_0 = 0.50%; Q = 210 l/s; e_d = 40 mm

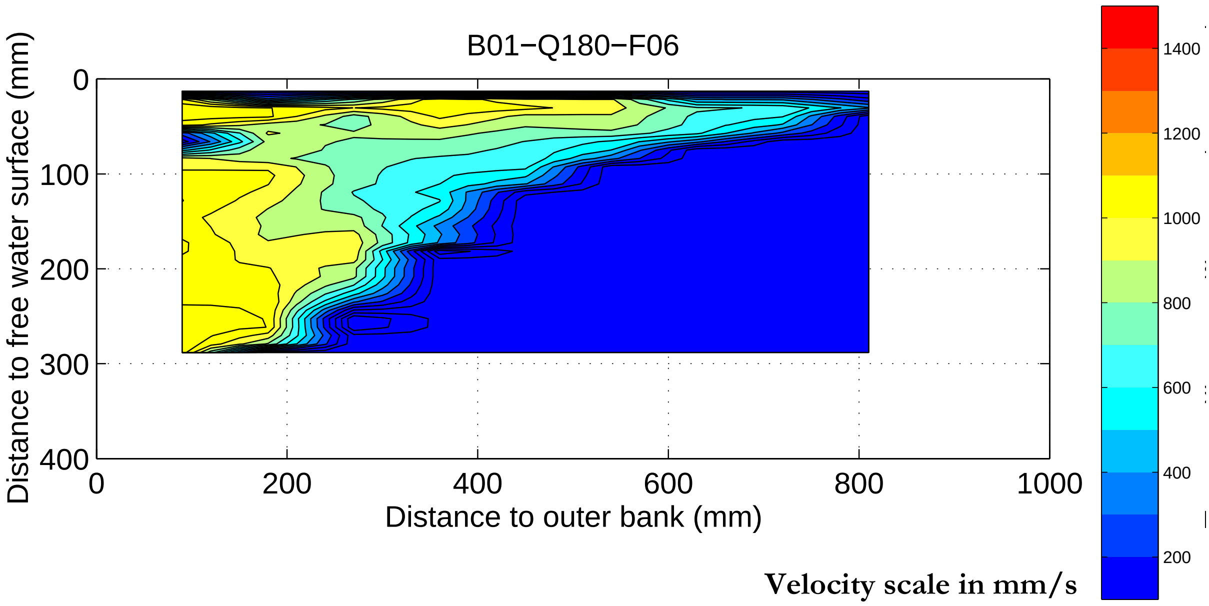
WITH MR SPACING **4°**	WITH MR SPACING **2°**
	
	
	
	
	
	
	

APPENDIX 11

VELOCITY DISTRIBUTIONS IN THE CROSS SECTIONS

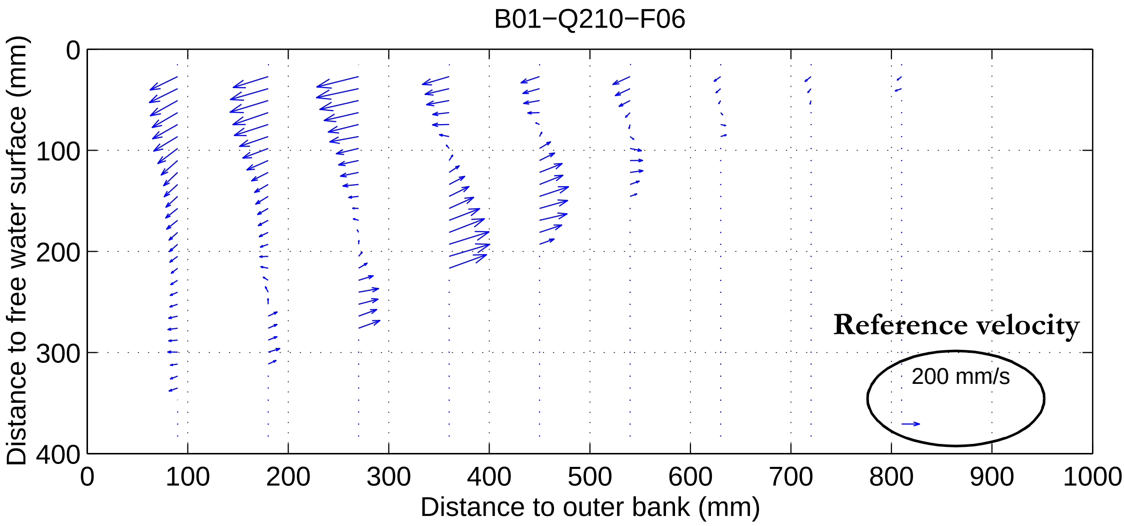
This Appendix gives the velocity measurements in the channel. All presented velocity measurements were made at an initial bed slope of 0.50%. The influence of the macro-roughness is shown for a discharge of 210 l/s. The velocity profiles are located every 15° at cross sections from 10° to 85°. Due to the big number of measurement points over the depth (128 points), only every 4th point was used for the vector plots to facilitate the reading.

The first part (Appendix 11.1 and 11.4) shows the tangential velocities. The irregularities (stair-like behavior) next to the ground are due to the interpolation of the data points.

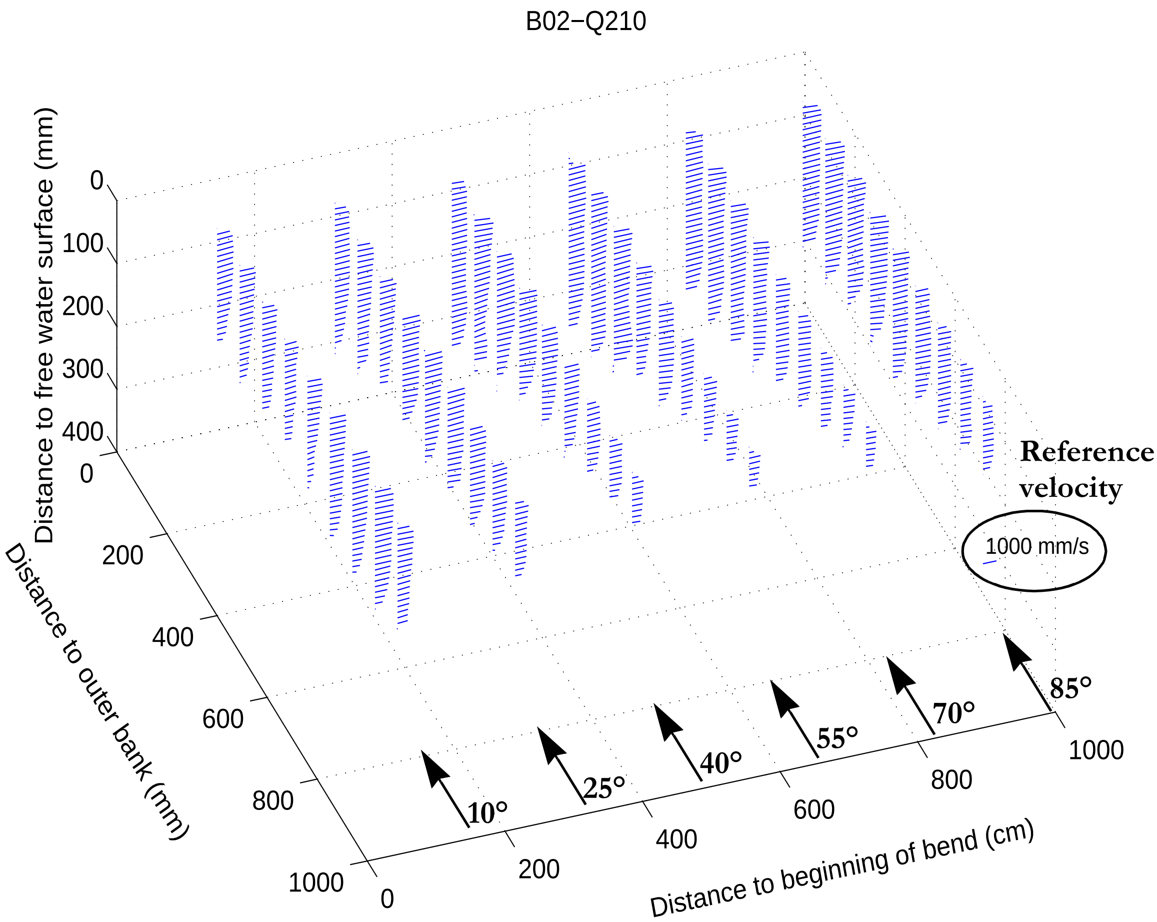


Velocity scale in mm/s

The second part (Appendix 11.2 and 11.5) presents the velocity vector in the cross section (radial and vertical velocity components. The plot gives a view in downstream direction.



The last part gives the 3D-velocity vectors in the bend. The bend is represented as a prismatic block:



Additional information can be found in the report in Chapter 5.3.1 and 6.6.

11.1 Tangential velocities without macro-roughness

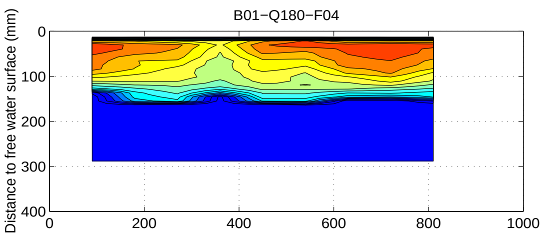
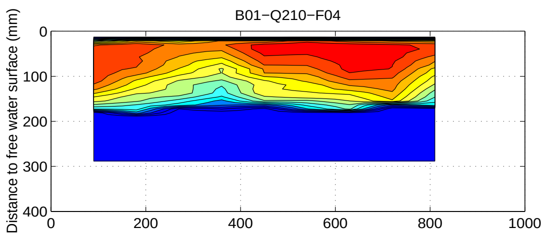
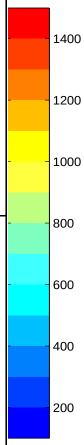
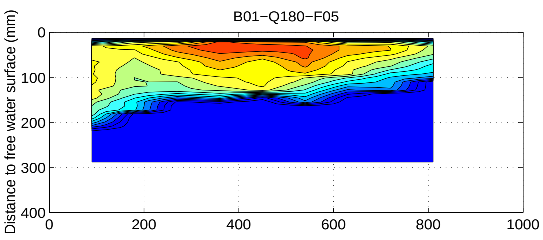
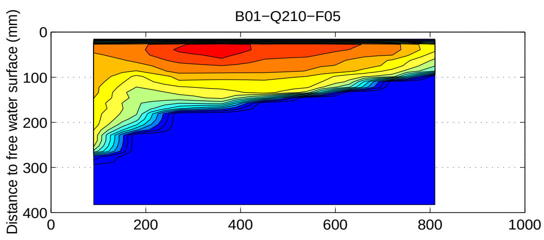
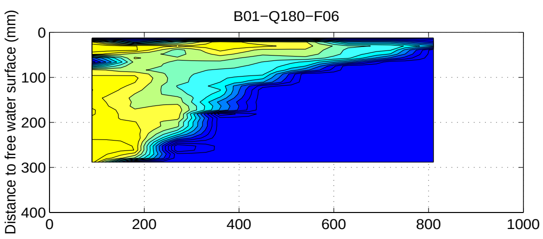
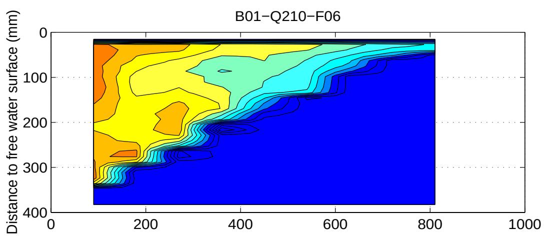
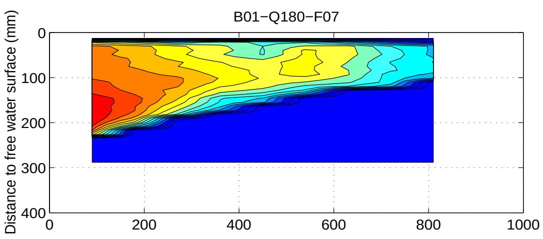
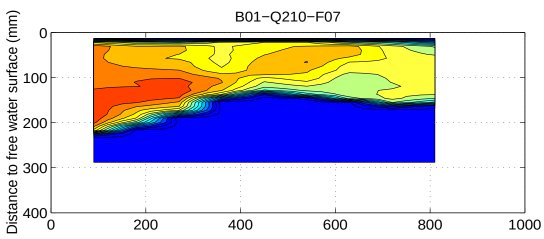
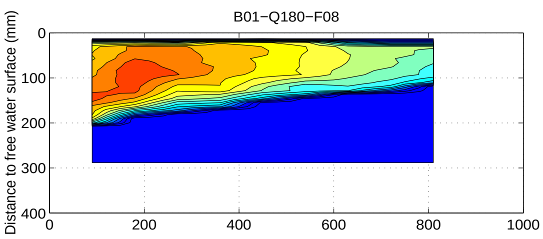
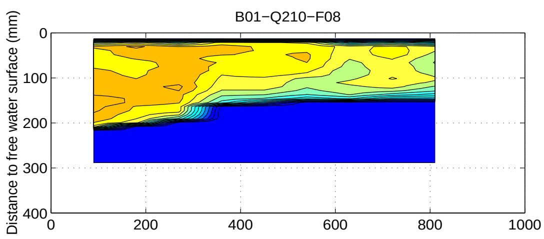
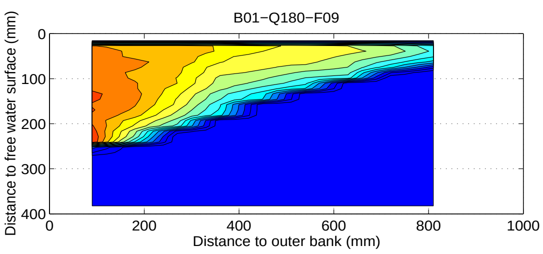
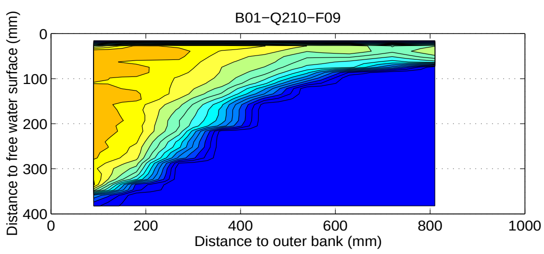
Pos.	Q=180 L/S	Q=210 L/S	
10°			
25°			
40°			
55°			
70°			
85°			

Table 11.1: Tangential velocities, without macro-roughness, $S_0 = 0.50\%$

11.2 Cross section velocities without macro-roughness

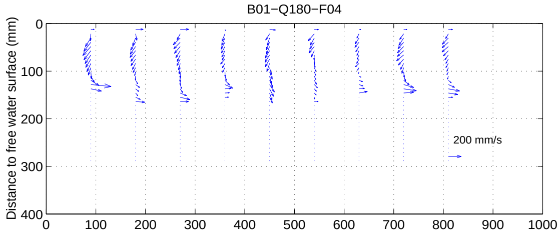
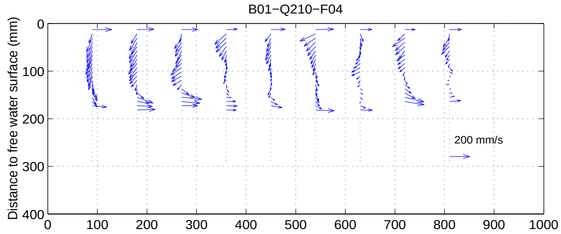
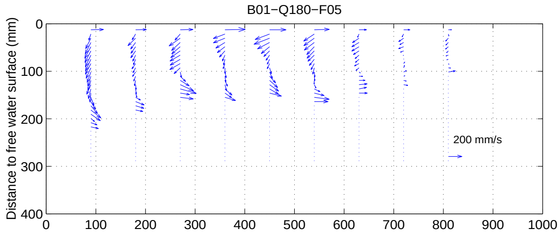
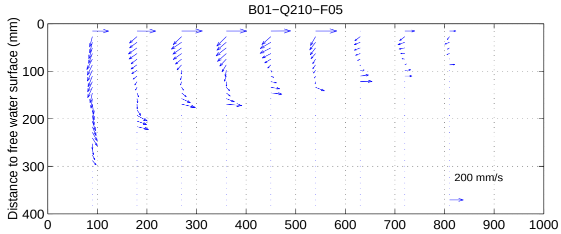
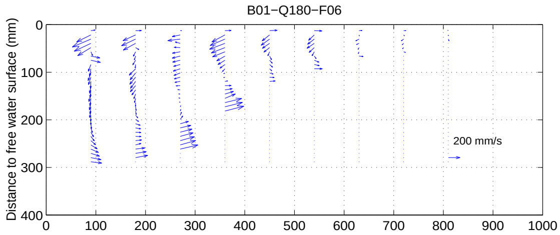
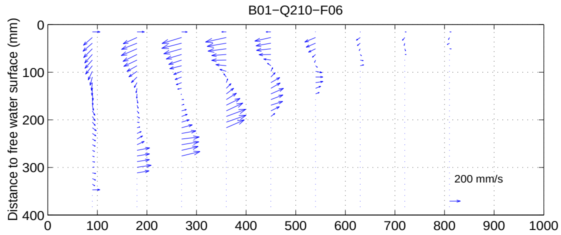
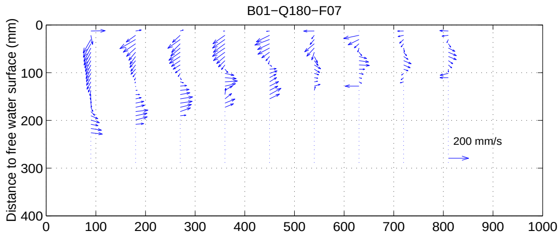
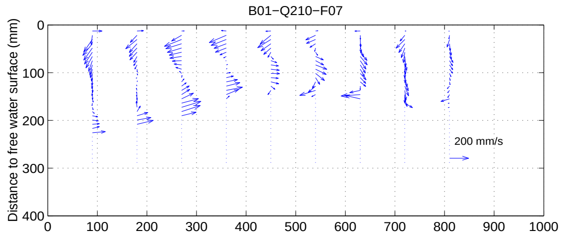
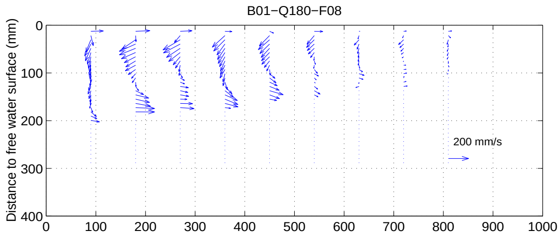
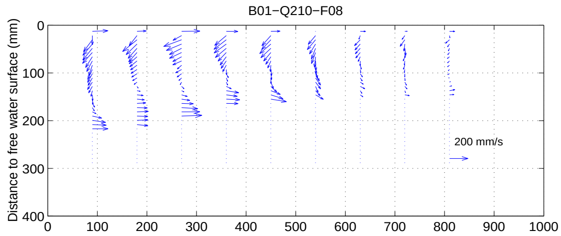
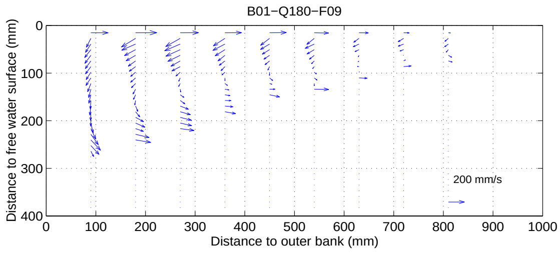
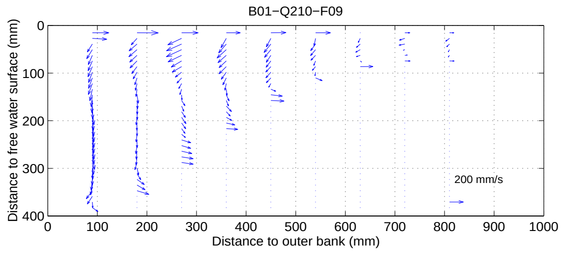
Pos.	Q=180 l/s	Q=210 l/s
10°		
25°		
40°		
55°		
70°		
85°		

Table 11.2: Velocities in the cross section, without mr, $S_0 = 0.50\%$

11.3 3D-Velocities without macro-roughness

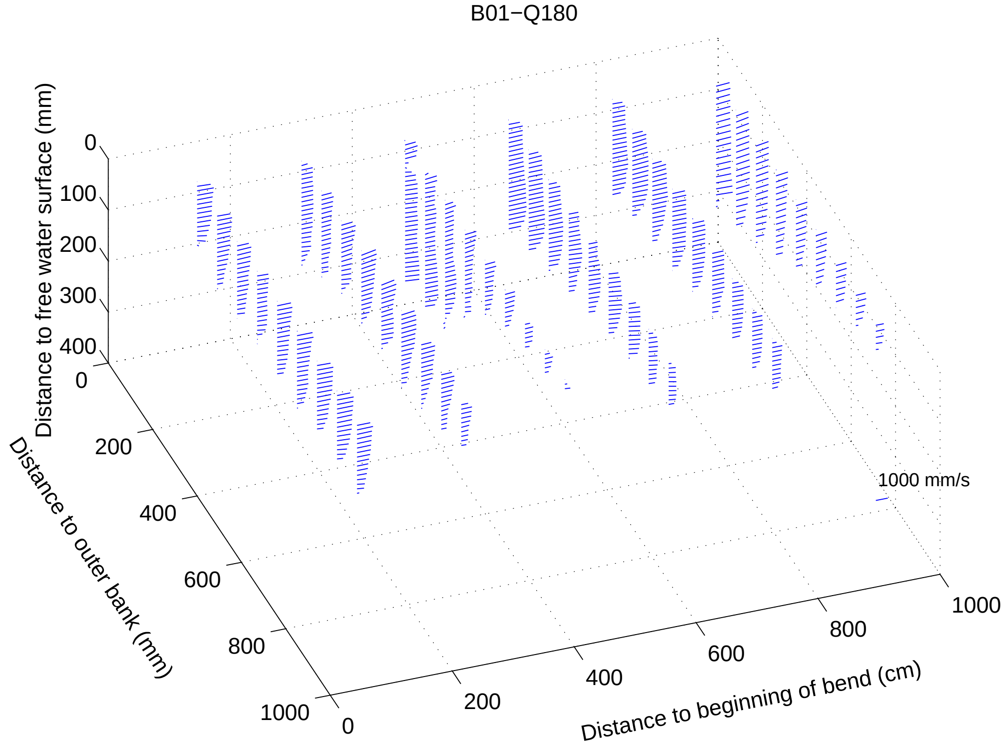


Figure 11.1: 3D-velocity field, S_0 = 0.50%, without macro-roughness, Q=180 l/s

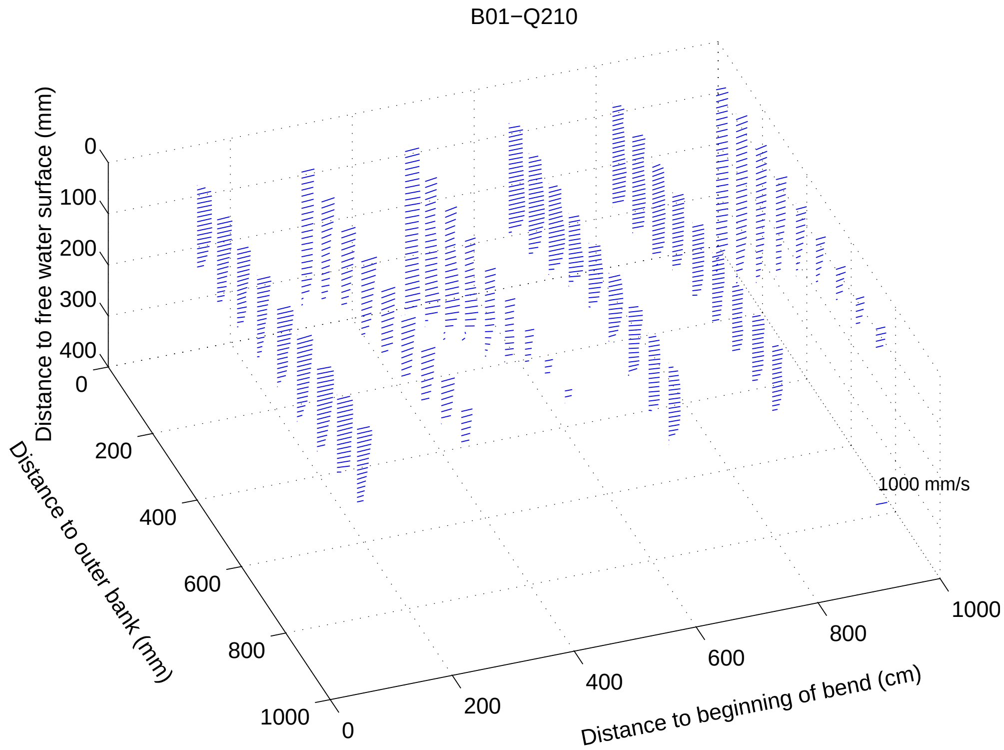


Figure 11.2: 3D-velocity field, S_0 = 0.50%, without macro-roughness, Q=210 l/s

11.4 Tangential velocities with macro-roughness

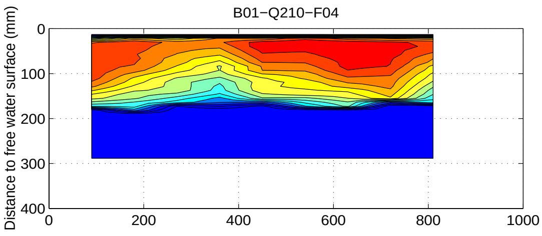
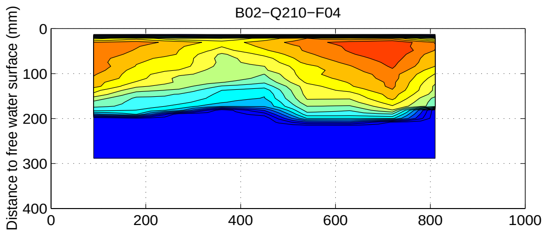
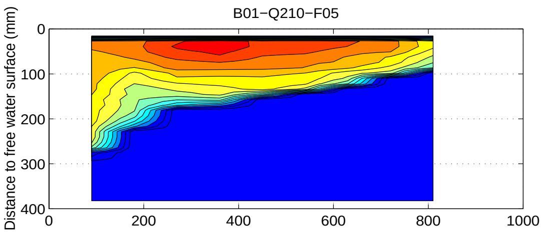
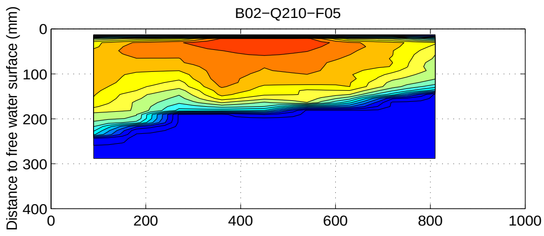
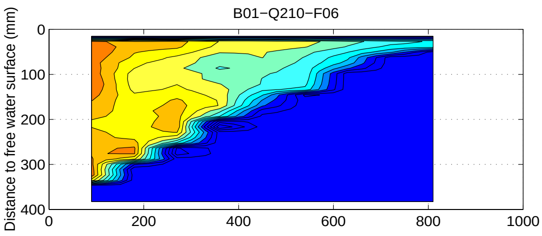
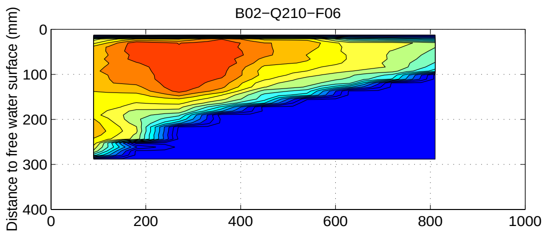
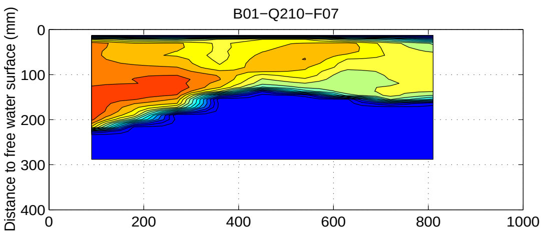
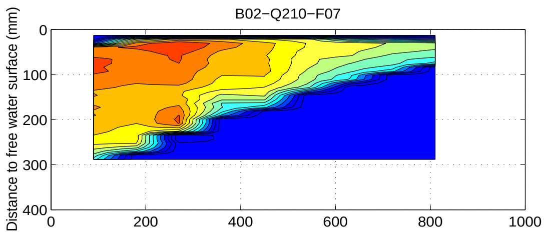
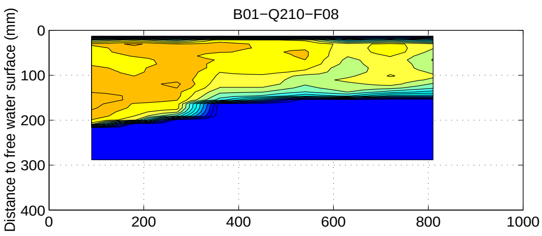
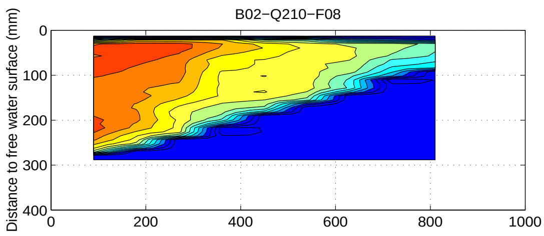
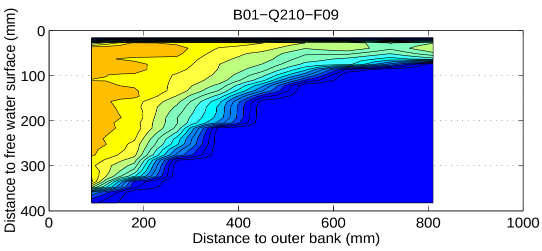
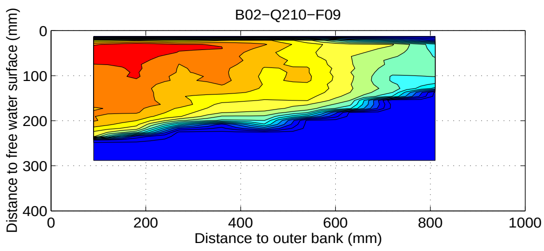
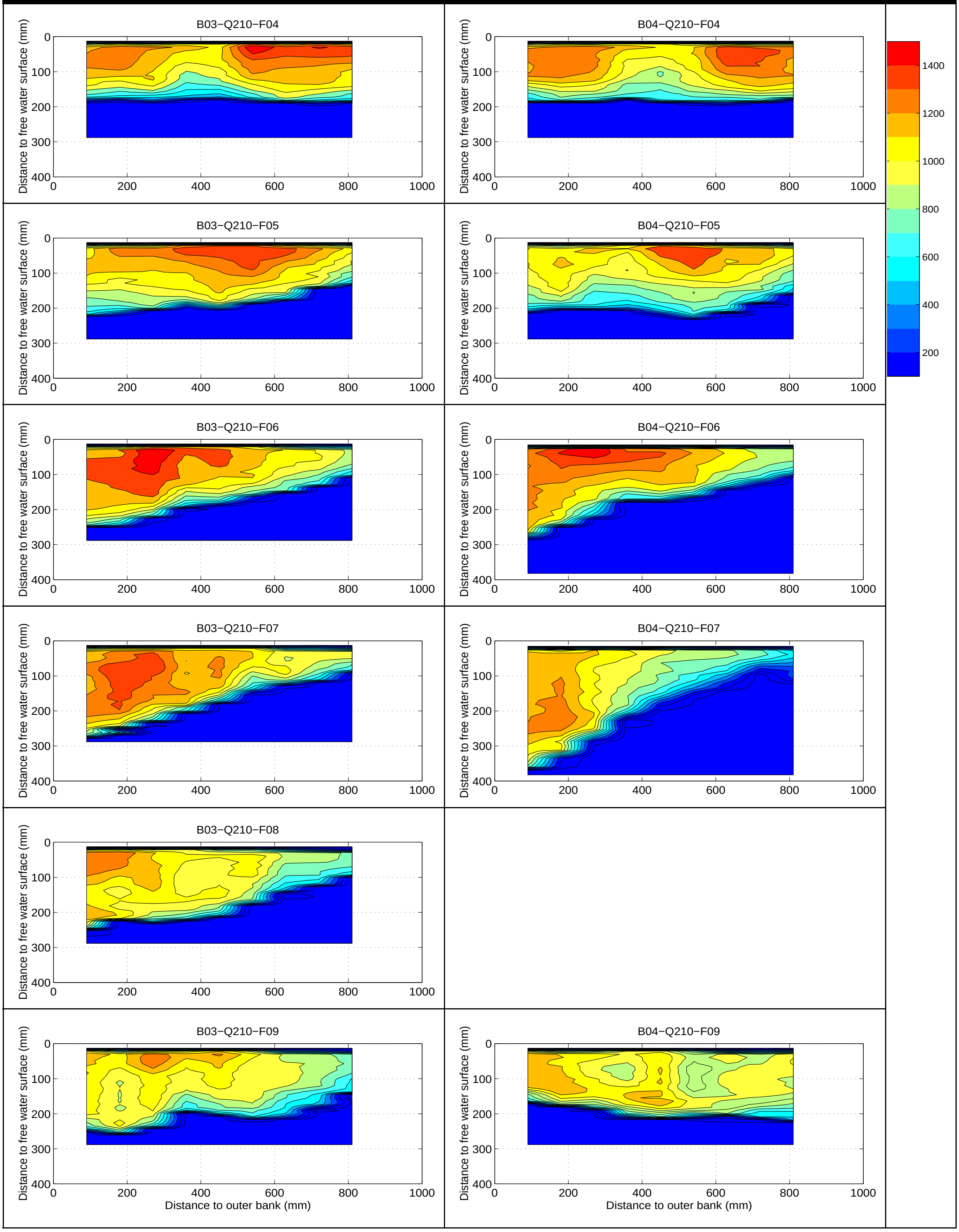
Pos.	without MR	MR-spacing 4°
10°		
25°		
40°		
55°		
70°		
85°		

Table 11.3: Tangential velocities, $S_0 = 0.50\%$, Q=210 l/s

MR-SPACING 2°	MR-SPACING 1°



Tangential velocities, S_0 = 0.50%, Q=210 l/s

11.5 Cross section velocities with macro-roughness

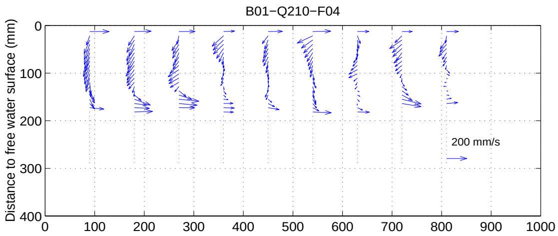
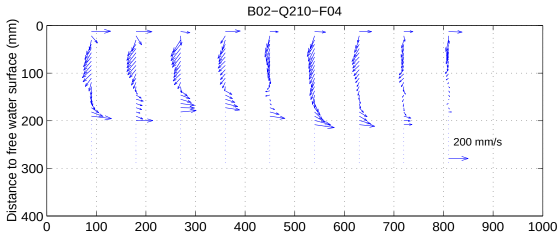
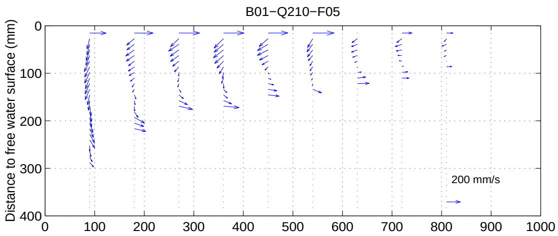
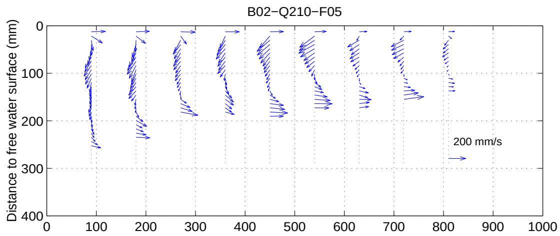
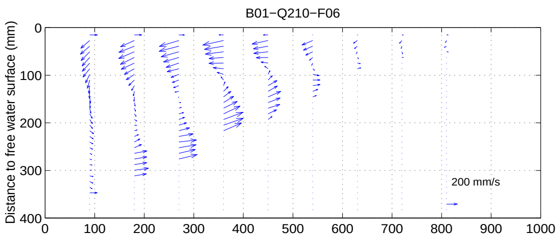
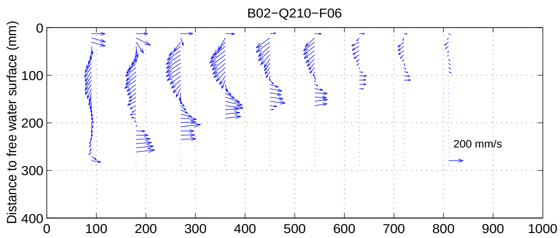
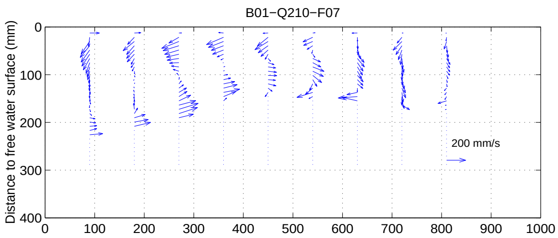
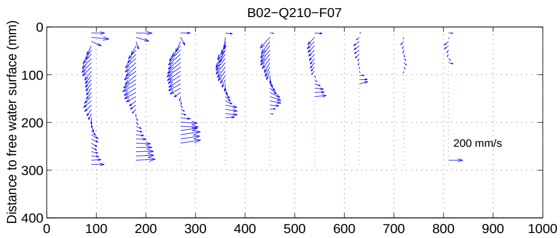
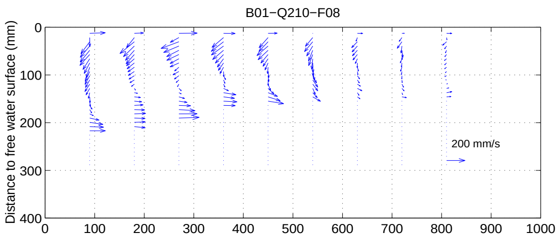
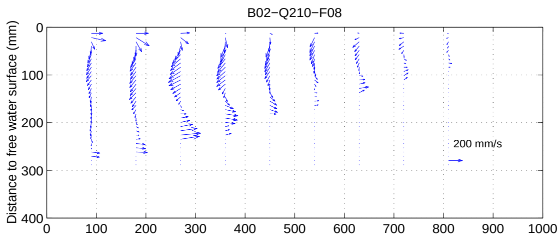
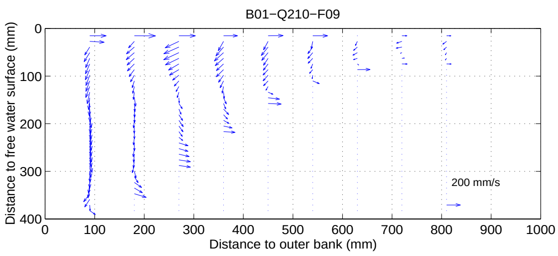
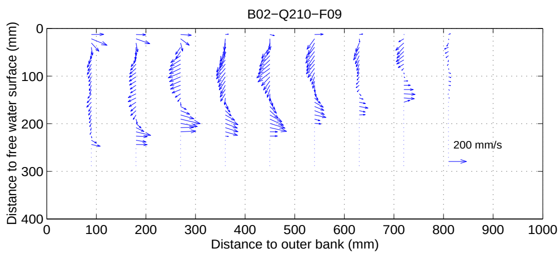
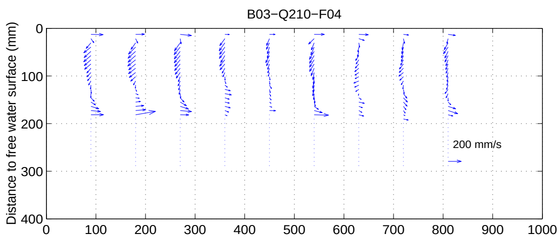
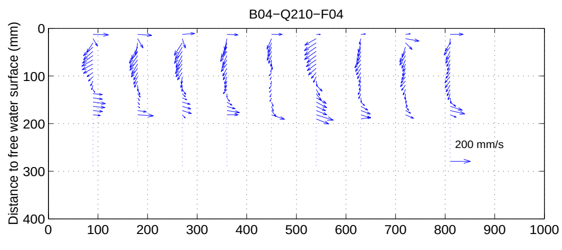
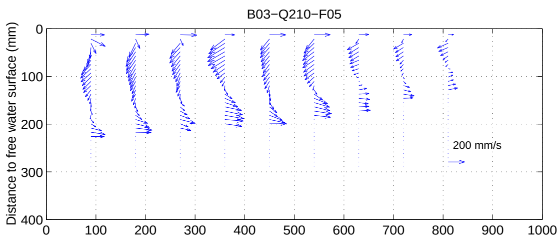
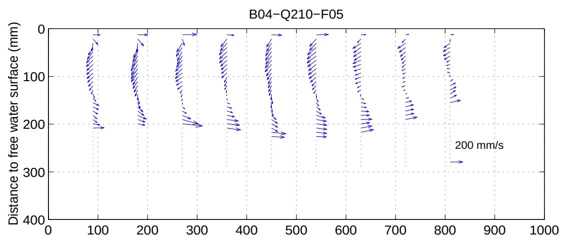
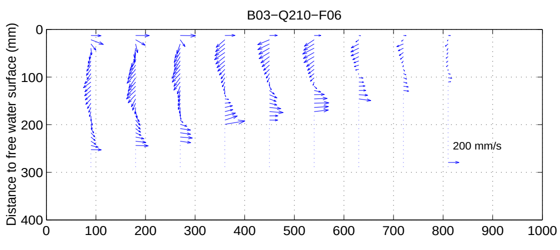
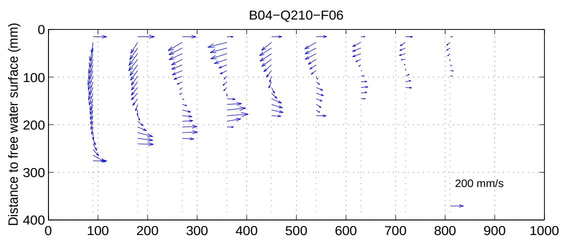
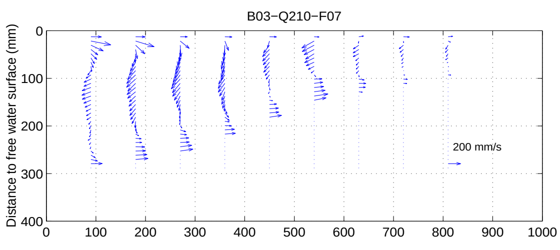
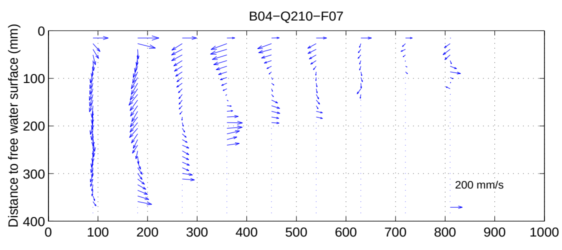
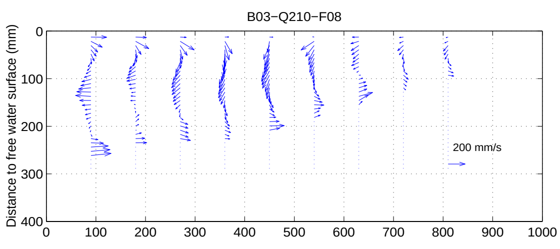
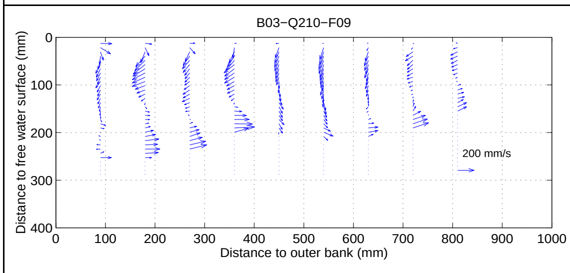
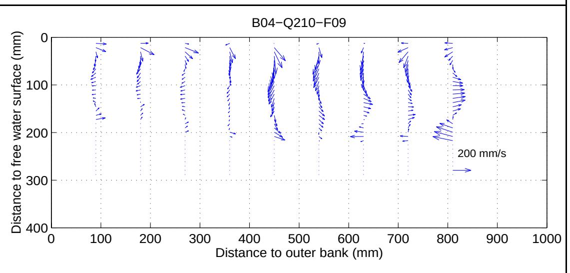
POS.	WITHOUT MR	MR-SPACING 4°
10°		
25°		
40°		
55°		
70°		
85°		

Table 11.4: Velocities in the cross section, $S_0 = 0.50\%$, Q=210 l/s

MR-SPACING 2°	MR-SPACING 1°
	
	
	
	
	measurement failed
	

Velocities in the cross section, $S_0 = 0.50\%$, Q=210 l/s

11.6 3D-Velocities with macro-roughness

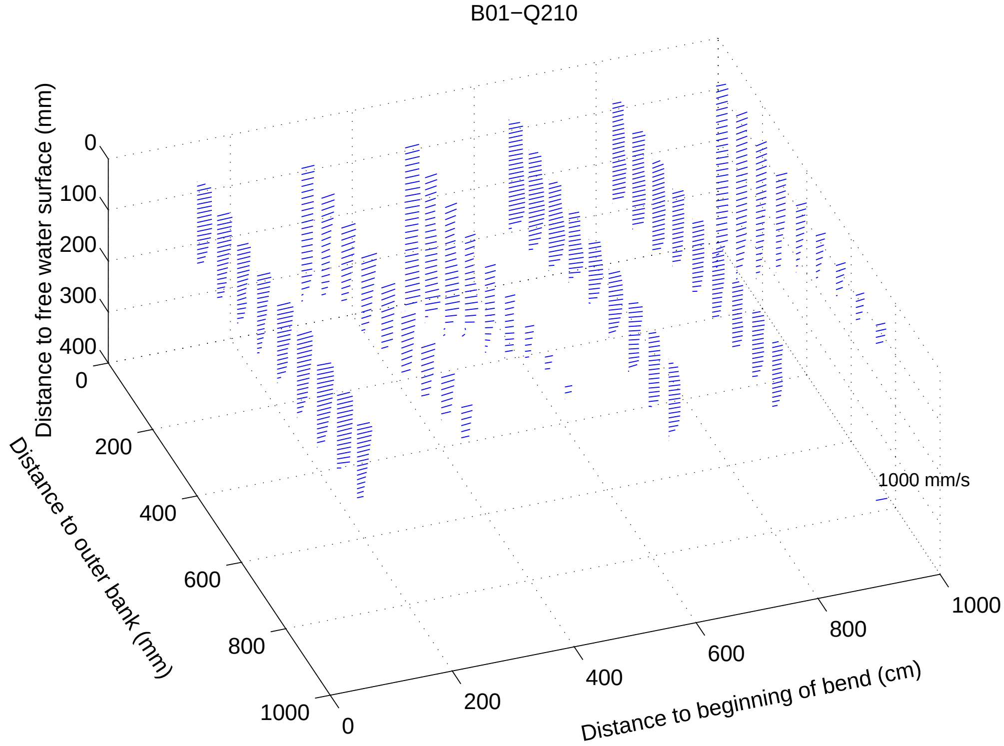


Figure 11.3: 3D-velocity field, S_0 = 0.50%, Q=210 l/s, without macro-roughness

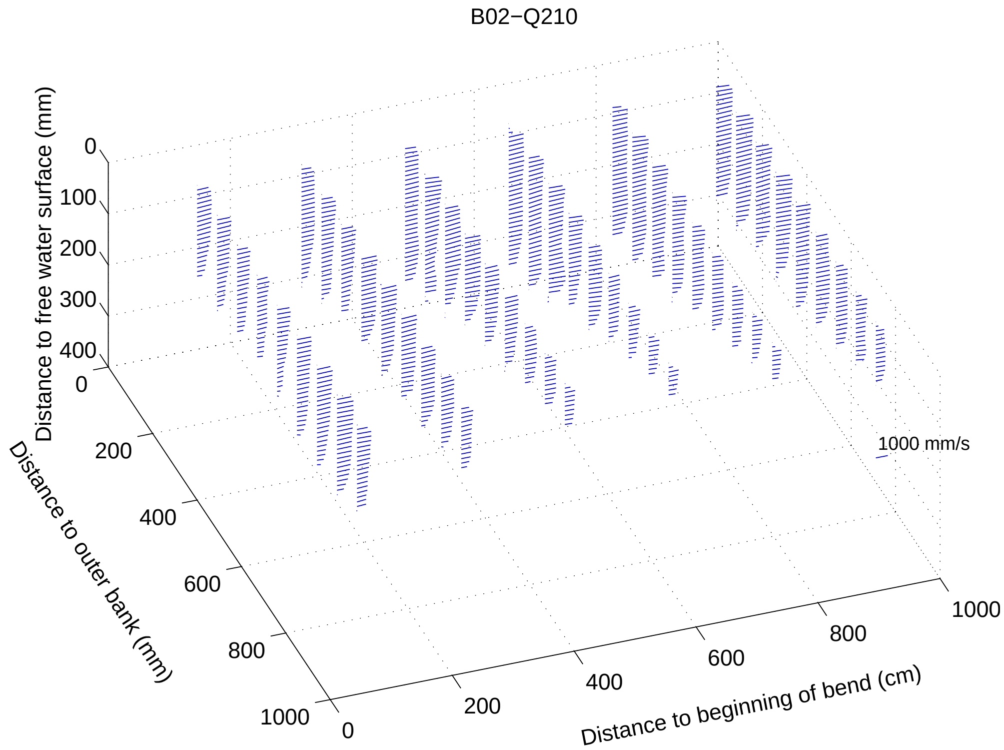


Figure 11.4: 3D-velocity field, S_0 = 0.50%, Q=210 l/s, mr-spacing = 4° (about 40 cm)

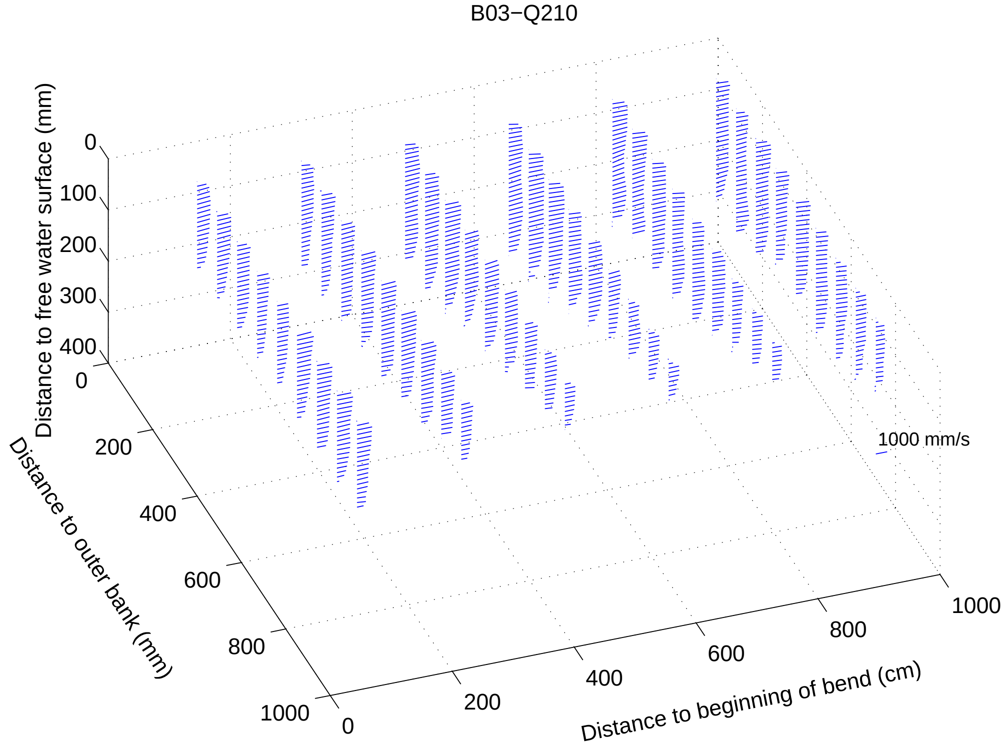


Figure 11.5: 3D-velocity field, S_0 = 0.50%, Q=210 l/s, mr-spacing = 2° (about 20 cm)

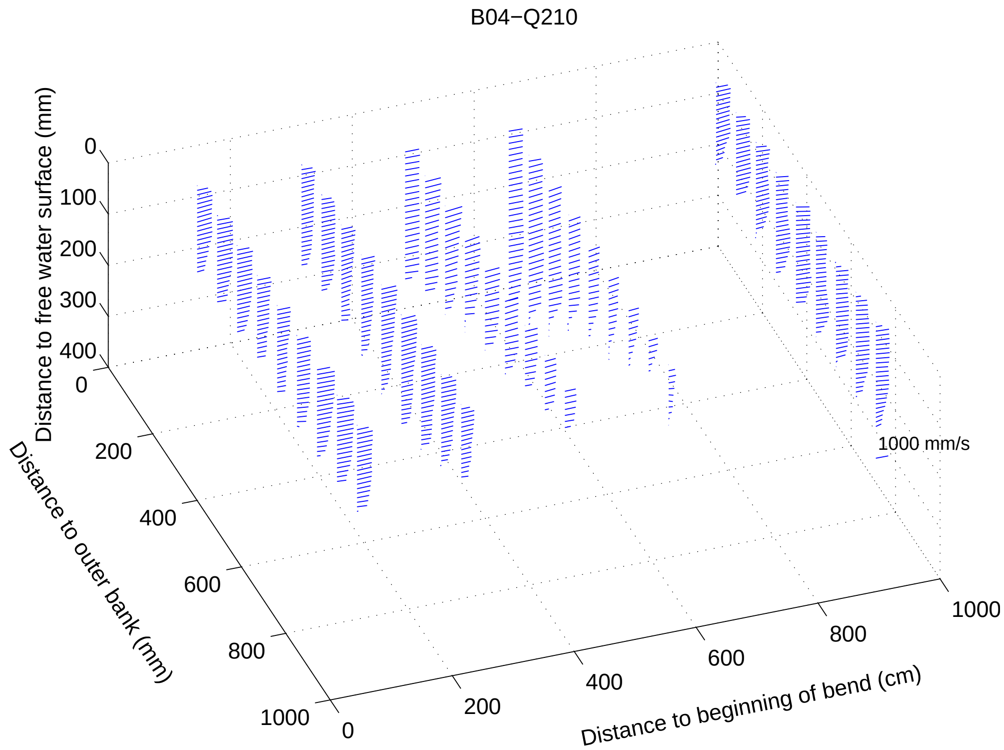


Figure 11.6: 3D-velocity field, S_0 = 0.50%, Q=210 l/s, mr-spacing = 1° (about 10 cm)

APPENDIX 12

RESULTS OF THE GENETIC PROGRAMMING

This appendix gives a small subset of results obtained with the genetic programming GPKernel. Additional information can be found in the report in chapter 7.3.5.

12.1 Results obtained with the data set without mr

Target	ID	Slope	Intercep	r2	RMS	CoD	Fit p noc	Hypothesis
hmax12/hm	1	1.091	-0.244	0.832	0.527	0.8323	0.2272	hmax12_hm = ((((sigma + sigma) + ((hm_B + ((Fr + ((Fr + (((Fr + (Fr / sigma)) * FrD) * Rc_B)) / sigma)) / sigma)) / sigma)) * ((((d90_hm + FrStar) - hm_B) + TauStar) - hm_B)) + 2)
	2	1.065	-0.296	0.830	0.5219	0.83	0.2207	hmax12_hm = (vsatr_v + (1.4909 * ((((Rc_B * FrStar) * d90_hm) + ((vsatr_v + vsatr_v) + ((((((d90_hm + TauStar) / sigma) * FrD) + TauStar) / sigma) * (Rc_B * TauStar)))) / ((((TauStar + hm_B) * Rc_B) * (hm_B - TauStar)) + vsatr_v))))
	3	1.021	-0.222	0.828	0.5187	0.8287	0.2232	hmax12_hm = ((((sigma + sigma) + (((FrD + Fr) + ((Fr + ((((hm_B + (Fr * FrStar)) + (Fr / sigma)) * FrD) * Rc_B)) / sigma)) / sigma)) * ((((d90_hm + FrStar) - hm_B) + TauStar) - hm_B)) + 2)
	4	1.076	-0.290	0.827	0.5242	0.828	0.2175	hmax12_hm = ((((d90_hm + (((d90_hm + (((d90_hm / FrStar) + FrStar) * (FrD * FrStar))) * FrD) * ((FrD * (d90_hm + (FrStar / sigma))) * (((FrStar / sigma) * Rc_B) * FrStar)))) / (hm_B + (d90_hm / Rc_B))) + 2.458) - (hm_B * Rc_B))
	5	0.987	0.108	0.826	0.5239	0.8263	0.2288	hmax12_hm = (1.5168 * ((((vsatr_v + vsatr_v) + ((Rc_B * TauStar) * (((d90_hm + TauStar) / sigma) * FrD))) + ((Rc_B * FrStar) * d90_hm)) / (((hm_B - TauStar) * (Rc_B * (vsatr_v + hm_B))) + vsatr_v)))
	6	1.177	-0.626	0.823	0.5506	0.8228	0.2279	hmax12_hm = (((((JeAll / TauStar) * (((((vsatr_v + FrStar) * (TanPhi + Rc_B)) + TanPhi) + FrD) + TanPhi)) + ((TauStar * 1.0393424) * (FrD / (TauStar + hm_B)))) / (TanPhi - TauStar)) / (TanPhi - TauStar))
	7	1.034	-0.063	0.823	0.5304	0.8228	0.2216	hmax12_hm = (((((((((TauStar * Rc_B) * (FrStar + Fr)) / sigma) / sigma) / sigma) / sigma) - hm_B) * ((Fr + Fr) / vsatr_v)) + (((d90_hm + ((Fr + (sigma * FrStar)) + Fr)) + (d90_hm + Fr)) + 1.26882267))
	8	1.050	-0.134	0.822	0.5299	0.823	0.2315	hmax12_hm = (1.526 * ((((Rc_B * FrStar) * d90_hm) + ((vsatr_v + vsatr_v) + (((FrD * (d90_hm + TauStar)) / sigma) * (TauStar * Rc_B)))) / (vsatr_v + ((FrStar * Rc_B) * (hm_B - TauStar)))))
	9	0.983	0.171	0.821	0.537	0.823	0.2216	hmax12_hm = (((((FrD - (hm_B / vsatr_v)) / ((FrD / FrStar) - (Rc_B + (Rc_B + (FrD - (hm_B / vsatr_v)))))) + Fr) * (((FrStar + 0.75481623) + (Fr + hm_B)) - (hm_B / vsatr_v))) + ((Fr + Fr) / Fr))
	10	1.068	-0.351	0.817	0.5412	0.8192	0.2385	hmax12_hm = (((((JeAll + ((JeAll / (FrStar / ((TauStar + Rc_B) + FrD))) + (JeAll / d90_hm))) + (FrStar + (JeAll / d90_hm))) / (vsatr_v
	11	0.985	-0.015	0.814	0.5374	0.8181	0.2301	hmax12_hm = (((((JeAll * (((Rc_B / TanPhi) + Rc_B) * FrD)) + FrStar) / (0.117036738 + hm_B)) + (((Fr + (TanPhi + JeAll)) - (hm_B / vsatr_v)) + (TauStar / (d90_hm + d90_hm)))) / TanPhi)

Target	ID	Slope	Intercep	r2	RMS	CoD	Fit p noc	Hypothesis
hmax12/hm	12	1.072	-0.306	0.816	0.5424	0.8166	0.2335	hmax12_hm = ((vstar_v + ((Fr * ((((FrStar * (FrStar + (Fr + TauStar))) * MrSpac) / (hm * TanPhi)) * TauStar)) * FrStar)) + ((Fr - (hm_B / vstar_v)) + (MrDepth_MrSpac + 2.8)))
	13	0.967	0.132	0.815	0.538	0.8152	0.2257	hmax12_hm = (((Fr * ((MrSpac / B) * (FrStar - hm_B))) + (((FrStar * ((hm_B - FrStar) - ((TauStar * (Fr / hm_B)) - hm_B))) + Fr) * ((B / MrSpac) / hm_B))) + (TauStar / TauStar))
	14	0.947	0.194	0.814	0.5411	0.8144	0.2471	hmax12_hm = (((((MrSpac / B) * (FrStar - hm_B)) * Fr) + (((B / MrSpac) / hm_B) * (Fr - (FrStar - hm_B)))) + (TauStar / TauStar))
	15	0.950	0.198	0.809	0.5509	0.8095	0.2152	hmax12_hm = ((((Fr * FrStar) * FrStar) + ((Fr * ((((FrStar + d90_hm) * MrSpac) / (hm * TanPhi)) * TauStar)) * FrStar)) + ((((Fr + MrDepth_MrSpac) - (hm_B / vstar_v)) + (FrStar * TauStar)) + ((Fr * (TauStar * JeAll)) + 2.6)))
	16	0.941	0.191	0.808	0.5522	0.8103	0.2406	hmax12_hm = (((Fr + ((Fr * ((((FrStar + FrStar) * MrSpac) / Rh) * TauStar)) * FrStar)) - (hm_B / vstar_v)) + ((FrStar - (TauStar * 2.1))

Target	ID	Slope	Intercep	r2	RMS	CoD	Fit p noc	Hypothesis
ScourLoc1	17	0.938	2.501	0.885	4.521	0.8849	0.2324	ScourLoc1 = (JeAll - (((sigma * (d90_hm - TanPhi)) / (hm_B * (Fr + vsatr_v))) + ((((sigma * ((JeAll * FrD) / (FrD - sigma))) * (sigma - (Rc_B - 3.75))) - ((Rc_B / (Rc_B - sigma)) * (FrD - sigma))) - (FrD / vsatr_v))))
	18	1.098	-4.381	0.794	6.0545	0.7941	0.2111	ScourLoc1 = (((((((((FrD + ((sigma + vsatr_v) + hm_B)) + Fr) / Fr) + (FrD - (((hm_B - d90_hm) * (((Rc_B * TanPhi) / (sigma - FrD)) + Fr)) + Rc_B))) / 0.61177) + sigma) + Rc_B) / 0.46067) + (TanPhi / hm_B))
	19	1.021	-0.910	0.759	6.4091	0.7618	0.2079	ScourLoc1 = ((vsatr_v + ((d90_hm / TauStar) * (sigma * d90_hm))) + (((((((sigma + (vsatr_v / hm_B)) / (d90_hm / TauStar)) + FrD) + TauStar) + TanPhi) / FrStar) + (((5. - (Rc_B - sigma)) / FrStar) + Rc_B)))
	20	1.032	-1.402	0.757	6.4839	0.7567	0.2247	ScourLoc1 = (((sigma * FrD) * ((hm_B - -15.678) / ((sigma + 0.36) / TanPhi))) + ((TanPhi / (Fr / sigma)) + (((TanPhi / Fr) / Fr) /

Target	ID	Slope	Intercep	r2	RMS	CoD	Fit p noc	Hypothesis
ScourLoc1	21	0.957	1.914	0.753	6.5398	0.7531	0.2002	ScourLoc1 = ((((2.54614568 + (sigma / Fr)) + (FrD + 1.1)) / (hm_B + FrStar)) + ((JeAll + Fr) + (FrD + ((Fr + ((FrD + ((Fr + FrD) + (Fr + (FrD + ((sigma - Rc_B) / Fr))))) / Fr)) / Fr))))
	22	0.963	1.658	0.752	6.5464	0.7522	0.2	ScourLoc1 = (((FrD + (((TauStar + hm_B) + TauStar) + (sigma + ((FrStar + (FrD + FrD)) / (hm_B + FrStar))))) + ((FrD / FrStar) + ((TanPhi + sigma) - Rc_B))) + ((TanPhi + FrD) / (((hm_B + Fr) - TanPhi) + FrStar)))
	23	0.961	1.900	0.752	6.5543	0.7521	0.2053	ScourLoc1 = (((TanPhi + FrD) / (((hm_B + Fr) - TanPhi) + FrStar)) + (((FrD / FrStar) + ((TanPhi + sigma) - Rc_B)) + (FrD + ((sigma + ((FrStar + (FrD + FrD)) / (hm_B + FrStar))) + TauStar))))
	24	0.985	0.353	0.750	6.6149	0.7464	0.2265	ScourLoc1 = ((FrD / (((FrD + Rc_B) * TauStar) / sigma)) + ((sigma + (FrD / (Fr / FrD))) + ((FrD + 3.52) / (sigma / 3.96))))

Target	ID	Slope	Intercep	r2	RMS	CoD	Fit p noc	Hypothesis
ScourLoc2	25	0.838	74.306	0.394	4.5368	0.8827	0.2319	ScourLoc2 = (((sigma + ((FrStar / (((13.22 / FrD) - FrD) / Rc_B)) + (((8.365 - Rc_B) / (hm_B + Fr)) - (sigma / ((((11.97 / FrD) - FrD) / (hm_B + (Fr + ((Fr - FrD) / Rc_B)))) + Rc_B))))) + FrD) / FrStar)
	26	0.861	70.846	0.376	6.3088	0.7689	0.207	ScourLoc2 = ((((vsatr_v + (vsatr_v / (FrD / sigma))) / (d90_hm + hm_B)) * (((((vsatr_v + vsatr_v) / (hm_B + (FrStar * (FrStar + Fr)))) / FrStar) + TanPhi) / FrStar)) + ((3 * (FrD * FrD)) + (FrD * 3)))
	27	0.901	71.588	0.342	6.5973	0.7474	0.2384	ScourLoc2 = ((Rc_B + (FrD / (vsatr_v + d90_hm))) + ((((5.03865 + FrD) + (sigma - Rc_B)) + sigma) / (hm_B + FrStar)))

Target	ID	Slope	Intercep	r2	RMS	CoD	Fit p noc	Hypothesis
ScourLoc2	28	1.133	-16.0	0.676	10.05	0.6759	0.182	ScourLoc2 = ((((-1.4084041 * Rc_B) + (((((-1.4672766 * FrD) / Rc_B) + (Rc_B / -1.08963454)) / 9.73) + Rc_B)) / ((FrD + (-1.4892728 / (FrD + FrD))) + (-1.4677951 * Rc_B))) + ((FrD + (9.36 - Rc_B)) * (9.73 + Rc_B)))
	29	1.128	-13.3	0.670	10.051	0.6703	0.1856	ScourLoc2 = ((((-1.4672766 * Rc_B) + (((Rc_B + (Rc_B / -1.08963454)) / 9.73) + Rc_B)) / ((FrD + (-1.4892728 / (FrD + FrD))) + (-1.4677951 * Rc_B))) + ((FrD + (9.22 - Rc_B)) * (9.73 + Rc_B)))
	30	0.976	3.038	0.665	9.9945	0.6655	0.1769	ScourLoc2 = ((12.174943 * 10.6214104) - ((((((((Rc_B - FrD) / (TauStar + (Rc_B - FrD))) * (Rc_B + 11.0072079)) * Rc_B) + ((Fr + Rc_B) / Rc_B)) + ((TauStar + (Rc_B - FrD)) / ((Rc_B - 1.0952) - FrD))) / FrD) + vstar_v))
	31	1.004	-7.775	0.625	10.565	0.6254	0.1663	ScourLoc2 = ((((FrD + 3e+001) + (FrD + 3e+001)) + ((FrD + 3e+001) + 3e+001)) - ((FrD - Rc_B) * ((d90_hm + -7.48) + (sigma + (((Rc_B - FrD) * ((sigma + (Rc_B - FrD)) + (d90_hm + -7.68))) - (FrD - Rc_B))))))
	32	0.970	3.858	0.620	10.659	0.62	0.1841	ScourLoc2 = ((((Fr + (Fr + Rc_B)) + Fr) * ((FrD + FrD) - (Fr + (Fr + Rc_B)))) + (((3.01764035 + 9.) * (8.8 + FrStar)) + 3.05906868))

Table 12.1: A small selection of results obtained with GPKernel without macro-roughness (with Peters tests)

12.2 Results obtained with the dataset with mr

Target	ID	Slope	Interc.	r2	RMS	CoD	FitPNod	Hypothesis
hmax12/hm	101	0.941	0.102	0.896	0.445	0.895	0.256	hmax12_hm = ((ed/es + (((JeAll / ((ed/es + (ed/es + ((FrStar * (TanPhi - (FrStar + FrStar))) + ed/es))) * TanPhi)) * FrD) + (FrStar + (TanPhi * (Vstar/V))))) / (hm/B + (Vstar/V)))
	102	0.924	0.167	0.895	0.438	0.895	0.238	hmax12_hm = (FrD + ((((Rc/B / ((sigma * (((((hm/B * hm/B) * sigma) / TauStar) / TauStar) * ((ed/es + (d90/hm * hm/B)) * (hm/B / d90/hm)))) + d90/hm)) + (FrStar - ((sigma * (hm/B * FrD)) / d90/hm))) * d90/hm) * Fr))
	103	0.874	0.452	0.895	0.445	0.896	0.241	hmax12_hm = (FrD + ((((d90/hm - ((sigma * hm/B) / d90/hm)) + (Rc/B / ((sigma * (((ed/es + (hm/B * hm/B)) * (hm/B / TauStar)) * ((((hm/B * hm/B) * sigma) / TauStar) / TauStar))) + d90/hm))) * d90/hm) * Fr))
	104	0.894	0.328	0.894	0.440	0.893	0.247	hmax12_hm = (hm/B + ((((ed/es + (FrStar * (TanPhi - (FrStar + FrStar)))) + ((JeAll / ((TanPhi * (ed/es + ((TanPhi - (FrStar + FrStar)) * FrStar))) + ed/es)) * FrD)) + FrStar) / (hm/B + (Vstar/V))))
	105	0.939	0.232	0.894	0.449	0.893	0.265	hmax12_hm = (((Vstar/V) + ((ed/es + FrStar) + ((JeAll / ((((FrStar * (TanPhi - (FrStar + FrStar))) + ed/es) * TanPhi) + ed/es)) * FrD)))
	106	0.885	0.378	0.893	0.442	0.893	0.240	hmax12_hm = (2.28 + (((hm/B + Fr) + ((TauStar - hm/B) * (Rc/B + Rc/B))) * (3.09 * ((Rc/B + ((2.37 / ((((FrD + hm/B) - Rc/B) - 2.32) + ((FrStar + 3.17) + TanPhi))) + FrStar)) * (FrStar - hm/B)))))
	107	0.904	0.249	0.891	0.442	0.892	0.237	hmax12_hm = (((((FrD + (FrD / TanPhi)) * (JeAll * ((FrD / TanPhi) / TanPhi))) + TauStar) / ((hm/B + (TauStar / (Rc/B - Fr))) + (ed/es + ed/es))) + (FrD / (sigma + (FrD * FrStar)))) + ((ed/es + ed/es) + hm/B))
	108	0.883	0.326	0.889	0.448	0.889	0.246	hmax12_hm = ((hm/B + (Vstar/V)) + (((Vstar/V) + ((JeAll + FrStar) + (FrD * (JeAll / (ed/es + (TanPhi * (ed/es + (((FrStar * (TanPhi - (FrStar + FrStar))) + JeAll) + ed/es)))))))) / (hm/B + (Vstar/V))))
	109	0.853	0.360	0.881	0.468	0.881	0.262	hmax12_hm = ((FrD / (sigma + sigma)) + ((FrStar + (FrStar + Fr)) / (((1.0149 + (Rc/B / (ReStar * hm/B))) / (Rc/B * Rc/B)) + (Rc/B *
	110	0.899	0.341	0.878	0.468	0.880	0.267	hmax12_hm = (((d90/hm + FrStar) * (((FrD / ((Vstar/V) / JeAll)) / (FrStar + ed/es)) + FrD)) / (hm/B + (TanPhi + (-0.621393681 +
	111	0.936	0.962	0.876	0.475	0.878	0.261	hmax12_hm = ((Fr * (((TanPhi - ((JeAll + (JeAll + TauStar)) / (ed/es + (hm/B + ed/es)))) * (((hm/B + ed/es) / hm/B) - Rc/B)) + 3)) + 2)

Target	ID	Slope	Intercep	Correlat	RMS	CoD	Fit p no	Hypothesis
hmax12/hm	112	0.801	0.603	0.895	0.444	0.896	0.248	hmax12_hm = ((((((((Vstar/V) + TauStar) * MrSpac) * ((TauStar * Fr) / 1.4)) / Rh) + ((sigma * ((FrStar - hm/B) - hm/B)) - ((((TauStar * F
	113	0.875	0.292	0.894	0.440	0.895	0.235	hmax12_hm = ((((FrStar * (((((MrSpac / Rh) + (FrStar * (((MrSpac / hm) * TauStar) - ((((MrSpac / hm) * TauStar) + (Vstar/V)) + TauSta
	114	0.853	0.425	0.894	0.439	0.894	0.252	hmax12_hm = (((((((sigma + (((MrSpac / Rh) + ((d90/hm / TauStar) - (Vstar/V))) * Fr)) * 0.24882) * (FrStar + TauStar)) * FrStar) + (Fr +
	115	0.948	0.274	0.894	0.442	0.895	0.256	hmax12_hm = ((((((MrSpac * ((Vstar/V) + TauStar)) * ((TauStar * Fr) / 1.1)) / Rh) + (sigma * (((Vstar/V) + ((ed/es + ed/es) * (Fr * TauSt
	116	0.905	0.202	0.893	0.441	0.894	0.271	hmax12_hm = ((((((MrSpac * ((Vstar/V) + TauStar)) * ((TauStar * Fr) / 1.2)) / Rh) + (1.3 * ((FrStar - hm/B) - hm/B))) + 1.) + Fr)
	117	0.872	0.395	0.893	0.442	0.893	0.271	hmax12_hm = (d90/hm + (((Rh + (TauStar * ((MrSpac * (Fr + ((sigma * d90/hm) + d90/hm))) * (TauStar * (TauStar + 2.1))))) + hm) / hı
	118	0.959	0.248	0.892	0.448	0.893	0.277	hmax12_hm = ((((((((Vstar/V) + TauStar) * MrSpac) * ((TauStar * Fr) / 1.1)) / Rh) + ((FrStar - hm/B) - hm/B)) + Fr) + 1.1)
	119	0.912	0.300	0.891	0.445	0.893	0.237	hmax12_hm = (TanPhi - (((Rc/B * (Vstar/V)) - TanPhi) - ((ed/es + ((((Fr + hm/B) / (Rc/B * (((Vstar/V) * (MrSpac / Rh)) + (Vstar/V)))) + (
	120	0.928	0.171	0.888	0.452	0.889	0.302	hmax12_hm = (Fr + (((((Fr * TauStar) + (Vstar/V)) / (hm / MrSpac)) * TauStar) + (TauStar + Fr)))
	121	0.886	0.307	0.886	0.452	0.887	0.301	hmax12_hm = (((TauStar * Fr) * ((((MrSpac / hm) * TanPhi) * FrStar) + (TauStar * Fr))) + 1.72925019)
	122	0.886	0.308	0.886	0.452	0.887	0.313	hmax12_hm = (((TauStar * Fr) * ((((MrSpac / hm) * TanPhi) * FrStar) + TauStar)) + 1.72925019)
	123	0.886	0.306	0.886	0.452	0.887	0.327	hmax12_hm = (((TauStar * Fr) * (((MrSpac / hm) * TanPhi) * FrStar)) + 1.72925019)

Target	ID	Slope	Intercep	Correlat	RMS	CoD	Fit p no	Hypothesis
ScourLoc1	124	0.679	14.428	0.678	6.787	0.672	0.177	ScourLoc1 = (((((ed/es + ed/es) / ((ed/es + ed/es) + (hm/B - Fr))) + (((Vstar/V) + hm/B) + ((sigma / Fr) + ((hm/B + (((TauStar + hm/B) + ed/es) + ed/es)) / hm/B)))) / (Vstar/V)) - ((hm/B / ((TauStar / Rc/B) + ed/es)) - 1.028))
	125	0.679	14.428	0.678	6.625	0.679	0.183	ScourLoc1 = (Rc/B + (((0.995146334 + Rc/B) + (Rc/B + (((sigma / 0.50072521) + (((-2.102943 - (0.437273562 / d90/hm)) + ((1.04013717 + 1.55438721) / (ed/es + (Vstar/V)))) * (0.440248221 + (Rc/B * (ed/es - (Vstar/V)))))) / FrStar))) + (Fr / d90/hm)))
	126	0.674	14.410	0.672	6.713	0.670	0.176	ScourLoc1 = (((((ed/es * (((sigma / (Vstar/V)) + (Vstar/V)) / ((Vstar/V) + ed/es))) + FrD) / ((Fr * ((TauStar + hm/B) + TauStar)) + ed/es)) + ((((13 - sigma) + ((sigma / (Vstar/V)) + (Vstar/V))) - Rc/B) - ((Vstar/V) + Rc/B))) + (8.1 / sigma))
	127	0.637	16.098	0.666	6.778	0.665	0.179	ScourLoc1 = (((7.32664 + ((((ed/es / (TauStar / d90/hm)) / ((TauStar + ed/es) + ed/es)) * 9.59248) + (7.53953 / Rc/B))) * ((FrD / sigma) + sigma)) + (((((sigma * sigma) + TauStar) + (FrD / sigma)) + ed/es) / Fr))
	128	0.643	16.073	0.663	6.797	0.662	0.174	ScourLoc1 = (((23.08 + (sigma + ((ed/es / ((ed/es + JeAll) + JeAll)) / hm/B))) + hm/B) + ((((((((((FrD - hm/B) - FrStar) - FrStar) - hm/B) - hm/B) - hm/B) - Fr) + (ed/es / ((ed/es + JeAll) + JeAll))) / FrStar) / FrStar))
	129	0.638	15.827	0.661	6.811	0.661	0.174	ScourLoc1 = ((1.65601122 * (((((((TanPhi + sigma) / (((FrStar + (ed/es + hm/B)) + hm/B) + d90/hm)) + FrD) * 1.08924353) + FrD) - ((ed/es + ed/es) + ((Fr + sigma) + ed/es))) + (ed/es * ((sigma / (TauStar + ed/es)) / FrStar)))) * 2.96379709)
	130	0.686	13.746	0.661	6.811	0.661	0.176	ScourLoc1 = (((FrD - (sigma + ((sigma - ((d90/hm / ((((TauStar / Rc/B) + ed/es) * ((TauStar / d90/hm) + ((Fr / (d90/hm / TauStar)) + (d90/hm / TauStar)))) + (d90/hm / Rc/B))) + -2.6732)) * -2.7007))) / (Fr * FrStar)) * Fr)
	131	0.632	19.457	0.661	6.845	0.658	0.173	ScourLoc1 = (3e+001 + ((((((ed/es + TauStar) + 0.5005153) + FrD) * (TauStar + 0.4463221)) / TauStar) + ((Fr * Rc/B) / (((ed/es + (TauStar + ed/es)) + ed/es) * (TauStar - (sigma + (sigma + ((ed/es + TauStar) / (Fr * (ed/es + hm/B))))))))))
	132	0.646	15.518	0.659	6.829	0.659	0.175	ScourLoc1 = (((((TauStar / hm/B) - (Fr - (sigma + (FrD / sigma)))) + (((ed/es / TauStar) * FrD) * (d90/hm / (ed/es + (TauStar / sigma))))) * ((FrD + (sigma / (hm/B + Fr))) + (sigma + (FrD / sigma)))) + 13.35)
	133	0.617	16.927	0.655	6.876	0.656	0.172	ScourLoc1 = ((ed/es + (Vstar/V)) / ((hm/B + ((Vstar/V) + (((ed/es + ed/es) * ((ed/es + (ed/es + ed/es)) + ed/es)) + (Vstar/V)))) / ((((hm/B + (TanPhi + (sigma + TanPhi))) / Fr) + (TanPhi + (TanPhi + FrD))) / ((Vstar/V) + (-0.36 * (Vstar/V))))))
	134	0.635	16.853	0.649	6.949	0.649	0.173	ScourLoc1 = (((FrD + ((((ed/es / hm/B) + sigma) + (FrD + ((ed/es / (ed/es + d90/hm)) / (ed/es + d90/hm)))) + ((((FrStar / d90/hm) / Rc/B) - (d90/hm + hm/B)) + (ed/es / (ed/es + hm/B))))) / (0.692852259 + hm/B)) / FrStar)
	135	0.666	14.487	0.647	6.948	0.648	0.170	ScourLoc1 = (((TanPhi / Fr) + ((TanPhi + (((TanPhi + ((TanPhi + (TanPhi - (hm/B / ((Vstar/V) + (TanPhi * (ed/es * Rc/B)))))) / TanPhi)) / TanPhi) / (Vstar/V))) - (sigma / TanPhi))) + ((1.577 + sigma) / (Fr * (((Vstar/V) / TanPhi) / TanPhi))))
	136	0.672	14.652	0.646	6.963	0.646	0.172	ScourLoc1 = ((sigma + (((((FrD + (((Vstar/V) + (ed/es / (TauStar + ed/es))) / hm/B)) + ((sigma / (hm/B + Fr)) / Fr)) / ((Vstar/V) + (Vstar/V))) + (0.4843 / hm/B)) + (FrD + sigma))) + ((Vstar/V) + (ed/es / (TauStar + ed/es))))

Target	ID	Slope	Intercep	Correlat	RMS	CoD	Fit p no	Hypothesis
ScourLoc1	137	0.610	17.385	0.659	6.858	0.659	0.173	ScourLoc1 = (((14 / sigma) / (-1.10085762 + Rc/B)) + ((((10.969317 + (-0.99416447 + 9.6783514)) + FrD) / sigma) + (FrStar + (FrStar
	138	0.645	15.671	0.655	6.867	0.655	0.172	ScourLoc1 = ((((((8.570672 + FrD) + 9.5934744) + FrD) / sigma) + (FrStar + ((sigma / FrStar) * (FrD + ((TanPhi / (((Vstar/V) - FrStar) -
	139	0.744	11.253	0.610	7.588	0.608	0.162	ScourLoc1 = (((d90/hm / FrStar) + ((((ed/es * ((d90/hm / d90/hm) + ((sigma + FrStar) / (JeAll + (JeAll + (TanPhi * (JeAll + (TanPhi * ec
	140	0.524	20.729	0.505	8.236	0.505	0.133	ScourLoc1 = (((sigma + ((TanPhi - Fr) + (sigma + ((Rc/B * ed/es) + ((0.1991 - hm/B) - sigma))))) / 5.87961972e-002) - (ed/es + ((Rc/B

Target	ID	Slope	Intercep	Correlat	RMS	CoD	Fit p no	Hypothesis
ScourLoc2	141	0.621	36.726	0.718	9.775	0.718	0.189	ScourLoc2 = ((((42.6895981 + (FrD + (((FrD - Rc/B) / FrD) / ((sigma - FrD) * Rc/B)))) + (((((sigma - FrD) / (FrD - Rc/B)) / FrD) - FrD) - I
	142	0.605	38.869	0.715	9.878	0.715	0.188	ScourLoc2 = (((((FrD - ((-3.61804056 * ((FrD - sigma) * ((FrD - sigma) * FrD))) + (((Rc/B - sigma) * Rc/B) * Rc/B))) + (((Rc/B - sigma) /
	143	0.712	27.445	0.706	9.741	0.706	0.193	ScourLoc2 = ((((44.3062325 + (FrD + (sigma + (((FrD - Rc/B) / Rc/B) / (FrD * (sigma - FrD)))))) + ((FrD - Rc/B) - Rc/B)) + 42.8187065)
	144	0.683	31.215	0.693	9.958	0.693	0.195	ScourLoc2 = ((Rc/B - (((((5.6 + Rc/B) * (hm/B + FrD)) * ((Rc/B + (Vstar/V)) - (FrD + FrStar))) / sigma) + (sigma + FrD))) + (6.1 * (Rc/B
	145	0.660	34.474	0.691	9.991	0.691	0.184	ScourLoc2 = ((((Rc/B + (hm/B * 3.74601)) + (18 + hm/B)) + ((0.9 + ((3.87632 + (hm/B * 3.74601)) - Fr)) + ((hm/B * (Fr * ((FrD - Rc/B) *

Table 12.2: A small selection of results obtained with GPKernel with macro-roughness (with Peters tests)

12.3 Computation of the scour reduction

Target	ID	Slope	Intercep	r2	RMS	CoD	Fit p noi	Hypothesis
ScourRed	301	0.123	-0.166	0.117	0.1086	0.8057	0.2142	ScourRed = (((MrDepth_MrSpac * (v + (TauStar + (hm * 4.04)))) - ((((((((B / (d90 + Q)) - 4.09914) - (Q / d90_hm)) / TauStar) - TauStar) / ((TauStar + -0.9) + v)) / Re) / ((Q + TauStar) * Q))) - Q)
	302	0.218	-0.208	0.100	0.1198	0.8108	0.213	ScourRed = (((Rh - ((((1.13 + JeAll) / (Q * Q)) / ((Q - Rh) * ReStar)) * d90_hm)) * (((TanPhi + MrDepth_MrSpac) / JeAll) / ((ReStar * Q) * ((JeAll + TauStar) + ((Rh * (MrDepth_MrSpac - B)) + Q))))) - (Q - MrDepth_MrSpac))
	303	0.291	-0.200	0.100	0.123	0.8239	0.2164	ScourRed = (((MrDepth_MrSpac * v) - ((((((((B / Q) - 4.40817) - (Q / d90_hm)) / TauStar) - (v / Q)) / (v + (TauStar + -0.9))) / Re) / (Q * (Q + Q)))) - (Q + ((Q + (Q + -0.9)) * Q)))

Target	ID	Slope	Intercep	r2	RMS	CoD	Fit p noi	Hypothesis
ScourRed	304	11.680	-0.306	0.119	0.2557	0.7667	0.2014	ScourRed = ((hm_B - (((d90_hm / ((FrD + d90_hm) - (((hm_B + FrStar) + d90_hm) / (d90_hm / d90_hm)))) / FrStar) / FrD)) * ((d90_hm + (FrStar * MrDepth_MrSpac)) / (TauStar / (((d90_hm / ((FrD + -5.74087e-002) - (FrStar + d90_hm))) / FrStar) / FrD))))
	305	0.534	-0.227	0.112	0.1735	0.7317	0.1922	ScourRed = ((hm_B - (((d90_hm / ((MrDepth_MrSpac + FrD) - ((TauStar + d90_hm) / FrStar))) / FrStar) / FrD)) * ((((d90_hm / ((FrD + hm_B) - MrDepth_MrSpac)) / FrStar) / FrD) / (TauStar / (((FrStar * MrDepth_MrSpac) + d90_hm) / (TauStar / (sigma / FrD))))))
	306	5.393	-0.310	0.102	0.2477	0.7608	0.2077	ScourRed = ((hm_B - (((d90_hm / ((FrD + -5.41769e-002) - (FrStar + d90_hm))) / FrStar) / FrD)) * (((FrStar * MrDepth_MrSpac) + (((d90_hm / FrD) / hm_B) / FrD)) / (TauStar / ((d90_hm / (FrD - MrDepth_MrSpac)) / FrStar))))

Table 12.3: Results of the computation of scour depth reduction obtained with GPKernel
The data set contained only the tests with ribs

		Hypothesis 2						
Target	ID	Slope	Intercep	r2	RMS	CoD	Fit p noi	Hypothesis 2
ScourRed	201	2.003	-0.504	**0.362**	0.227	0.5212	0.1377	ScourRed = (hm_B * (((vsatr_v + MrDepth_MrSpac) * (FrD + (d90_hm / ((MrDepth_MrSpac + (vsatr_v * vsatr_v)) +
	202	2.750	-0.541	**0.334**	0.2422	0.4672	0.1284	ScourRed = ((((MrDepth_MrSpac + (JeAll + MrDepth_MrSpac)) + ((Fr * hm_B) + (JeAll / ((hm_B * TauStar) + MrDepth_MrSpac)))) +
	203	-19.52	0.428	**0.269**	0.2582	0.5023	0.1327	ScourRed = (d90_hm / ((((MrDepth_MrSpac + (1.1 + Fr)) + Fr) + (Fr / (sigma + (Re * MrDepth_MrSpac)))) + (Fr / (sigma + (Re *
	204	-1.766	0.213	**0.262**	0.2691	0.5235	0.1401	ScourRed = (d90_hm / ((FrStar + (JeAll / ((hm_B * (MrDepth_MrSpac + d90_hm)) + MrDepth_MrSpac))) + MrDepth_MrSpac))
	205	-6.469	0.362	**0.256**	0.2553	0.468	0.1269	ScourRed = (d90_hm / (((JeAll + MrDepth_MrSpac) + JeAll) + (Fr + ((MrDepth_MrSpac + (JeAll / (((JeAll + JeAll) +
	206	-14.38	0.586	**0.251**	0.2516	0.5244	0.1386	ScourRed = (d90_hm / ((d90_hm / ((MrDepth_MrSpac + vsatr_v) + MrDepth_MrSpac)) + ((MrDepth_MrSpac + (FrStar +
	207	-1.796	0.213	**0.250**	0.2621	0.5152	0.1361	ScourRed = (d90_hm / (((JeAll / ((d90_hm * hm_B) + MrDepth_MrSpac)) + (FrStar + MrDepth_MrSpac)) + (JeAll / ((ReStar + Re) +

Target	ID	Slope	Intercep	r2	RMS	CoD	Fit p noi	Hypothesis 2
ScourRed	208	3.186	-0.680	**0.344**	0.2253	0.5541	0.1483	ScourRed = (hm_B * (Fr + (JeAll * (((hm / dm) / (MrSpac / hm)) + (MrSpac / hm)))))
	209	3.088	-0.785	**0.330**	0.2287	0.5459	0.1501	ScourRed = ((0.2 * (JeAll + ((JeAll * (MrSpac / hm)) + MrDepth_MrSpac))) + hm_B)
	210	-3.782	0.112	**0.320**	0.2511	0.5289	0.1454	ScourRed = (d90_hm / (((FrStar + (((MrSpac / Rh) * (d90_hm * d90_hm)) + MrDepth_MrSpac)) + hm_B) * FrD))
	211	-6.607	0.346	**0.311**	0.264	0.524	0.1462	ScourRed = (d90_hm / ((Fr + (MrDepth_MrSpac + hm_B)) + ((dm / hm) * ((hm_B * MrSpac) / hm))))
	212	-7.669	0.366	**0.276**	0.2533	0.5089	0.1468	ScourRed = (d90_hm / (hm_B + (vstar_v + ((MrSpac * (Fr / (MrSpac + Rc))) + (MrDepth_MrSpac + Fr)))))
	213	-7.669	0.366	**0.276**	0.2571	0.5142	0.1458	ScourRed = (d90_hm / (hm_B + (vstar_v + ((MrSpac * (Fr / (MrSpac + Rc))) + (MrDepth_MrSpac + Fr)))))
	214	-34401	0.270	**0.257**	0.278	0.5122	0.1338	ScourRed = (((d90_hm + TauStar) / ((d90_hm + Fr) + Re)) / (Fr + (MrDepth_MrSpac + (d90_hm + ((((d90_hm / Fr) + hm_B) / Rc) *
	215	-2.284	0.151	**0.239**	0.5903	0.5064	0.1392	ScourRed = (d90_hm / (MrDepth_MrSpac + ((FrD + (MrSpac / Rc)) * FrStar)))

Table 12.4: Results of the computation of scour depth reduction obtained with GPKernel
The data set contained all tests (without Peter)