

CHAPTER 4-DESCRIPTION AND LIST OF EXPERIMENTAL SERIES. INVESTIGATIONS OF COMPOSITE ROUGHNESS COEFFICIENT IN A RIVER WITH LOW FLOW

4.1. Experimental Investigation of friction factors and Manning's (n)

Sixteen series of experiments grouped into 2, A and B of eight series each were conducted to obtain the results. The following data was obtained with the help of a 12.1m long and 1m wide flume.

4.2. Group A (Smooth bed flume).

The pictures of the flume in the lab were taken to show the actual experiments conducted. For series 1 the pictures shows the flow in the flume without any elements present in the flume.

Series 1.1



Figure 4.1 Smooth flume without any element except water.

CHAPTER 4-DESCRIPTION AND LIST OF EXPERIMENTAL SERIES.

INVESTIGATIONS OF COMPOSITE ROUGHNESS COEFFICIENT IN A RIVER WITH LOW FLOW

The values seen table 4.1 are used to obtain table 4.2. these values in table 4.1 are in millimetres and were converted to metric units in table 4.2. The columns 4-8 are readings of the stilling pot for the respective discharges Q_s in parenthesis. The discharges in the tables are measured in m^3/hr

Table 4.1 Summary of measured depths on the calibrated stilling pots at the given discharge for smooth flume bed.

Column 1 Distances	Column 2 Zeros	Column 3 (100-zeros)	Column 4 D1 (Q=38.5)	Column 5 D2(Q=75.1)	Column 6 D3 (Q=109)	Column 7 D4 (Q=134)	Column8 D5(24)
1.1	61.45	38.55	0.740	20.83	34.54	46.80	-2.260
2.2	61.50	38.50	0.890	21.58	35.10	47.39	-1.500
3.3	60.30	39.70	1.280	21.87	35.50	47.89	-1.030
4.4	59.94	40.06	1.680	22.40	36.05	48.32	-0.490
5.5	59.67	40.33	2.430	23.23	36.98	49.32	0.270
6.6	58.74	41.26	2.830	23.57	37.16	49.68	0.750
7.7	58.00	42.00	3.690	24.31	38.07	50.49	1.800
8.8	57.34	42.66	4.220	25.00	38.64	50.91	1.990
9.9	57.07	42.93	5.130	25.92	39.65	51.91	2.930
11.	55.60	44.40	6.690	26.40	40.25	52.55	3.630

Procedure for table 4.1

Distances in column 1 are the distances of the perforated holes in the bed of the flume from the discharge point (tailgate). The zeros are the readings of the stilling pots when the flume is empty and dry. The 100-zeros column is obtained by subtracting the zeros value from 100. D1-D5 are the readings of the stilling pots for the corresponding discharges .

It is important to note that the direct readings from the stilling pots in table 4.1 do not give the actual depth of the water in the flume but are invert levels which have to be normalised by applying the procedures listed above

CHAPTER 4-DESCRIPTION AND LIST OF EXPERIMENTAL SERIES.

INVESTIGATIONS OF COMPOSITE ROUGHNESS COEFFICIENT IN A RIVER WITH LOW FLOW

The slope of the flume bed was determined by the help of a levelling instrument to be 0.00058. D1-D5 are readings obtained from the stilling pots. These values are selected after a series of adjustment of the tailgate of the flume at a fixed discharge Q by continuous plotting of the readings (I.e. the 10 different readings of D1-D5 in the stilling pots as seen in table 4.1 vs the distances as seen in table 4.1 column 1) of the stilling pot to obtain a slope of the water surface close to the known slope of the flume bed. Adding for instance $(D1 + \text{zeros value in table 4.1})/1000 = D1e$ (m) as seen in table 4.2. The term D_e means effective depth and is averaged to obtain the final effective depth which is in bold as seen in table 4.2.

Table 4.2 Summary of the normalised depth in metres against the stilling pots for smooth flume bed

D1e	D2e	D3e	D4e	D5e
0.062	0.082	0.096	0.108	0.059
0.062	0.083	0.097	0.109	0.060
0.062	0.082	0.096	0.108	0.059
0.062	0.082	0.096	0.108	0.060
0.062	0.083	0.097	0.109	0.060
0.062	0.082	0.096	0.108	0.060
0.062	0.082	0.096	0.109	0.060
0.062	0.082	0.096	0.108	0.059
0.062	0.083	0.097	0.109	0.060
0.062	0.082	0.096	0.108	0.059
0.062	0.083	0.096	0.109	0.060

Procedure for table 4.2.

$(D1 + \text{zeros value in table 4.1})/1000 = D1e$.

Similarly D2e-D5e were obtained using the same procedure for obtaining D1e.

The last values in table 4.2 which are bold are the average of the 10 effective depths. The averages are then used to calculate for the f and n in table 4.3

CHAPTER 4-DESCRIPTION AND LIST OF EXPERIMENTAL SERIES.

INVESTIGATIONS OF COMPOSITE ROUGHNESS COEFFICIENT IN A RIVER WITH LOW FLOW

The depths seen in table 4.3 were measured and the resistance coefficients, velocities, hydraulic radius and areas were calculated using this measured depths and discharges. This values of (f and n) calculated will be of importance when analysing the data in chapter 5.

Table 4.3 Summary of measured depths, resistance coefficients (f and n) at given discharges for the smooth flume bed.

Q (m ³ /h)	Q(m ³ /s)	Depth(m)	Area (m ²)	V(m/s)	R (m)	(S_f)	f	n
53.0	0.015	0.062	0.062	0.238	0.055	0.0006	0.046	0.015
94.0	0.026	0.082	0.082	0.317	0.071	0.0006	0.032	0.013
122	0.034	0.096	0.096	0.352	0.081	0.0006	0.029	0.013
147	0.041	0.108	0.108	0.376	0.089	0.0006	0.029	0.013
47.0	0.013	0.060	0.060	0.219	0.053	0.0006	0.051	0.016
60.0	0.017	0.065	0.065	0.256	0.058	0.0006	0.040	0.014
40	0.011	0.056	0.056	0.198	0.050	0.0006	0.058	0.017
50	0.014	0.060	0.060	0.231	0.054	0.0006	0.045	0.015
70	0.019	0.070	0.070	0.278	0.061	0.0006	0.036	0.014
80	0.022	0.076	0.076	0.292	0.066	0.0006	0.035	0.013

The smooth flume was tested alone with different discharges to establish its resistance characteristics.

Procedures for table 4.3

Discharge was given and depth was determined by trying to obtain uniform flow by adjusting the tail gate. S_f was obtained by plotting a graph of the depth against distance . f was obtained by equation 2.14 and n was obtained by equation 2.15. Area (m) was obtained by multiplying the depth by the width of the channel which is 1m. Velocity was obtained by dividing the discharge by the area. Hydraulic radius R (m) was obtained by dividing the area by perimeter of the flume (I.e. $1+2*\text{effective depth}$)

CHAPTER 4-DESCRIPTION AND LIST OF EXPERIMENTAL SERIES. INVESTIGATIONS OF COMPOSITE ROUGHNESS COEFFICIENT IN A RIVER WITH LOW FLOW

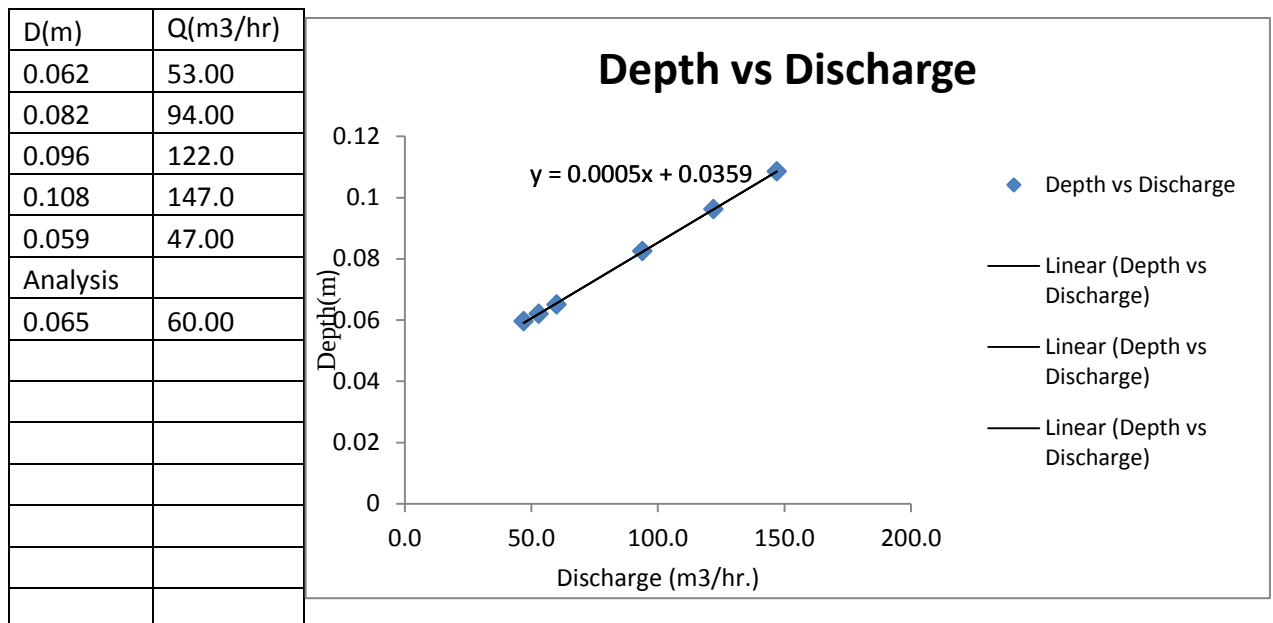


Figure 4.2 Stage-discharge graph for smooth bed flume.

Figure 4.2 above is the stage-discharge graph which is used for interpolating for other depths given discharge or other discharges given depths.

The remaining series listed below are found in the appendix and were obtained in a way similar to series 1.1.

4.3 Group B (Rough bed flume)

The rough bed flume is similar to the smooth bed flume except that the bed of the flume was lined with 19mm gravel stones. As seen in figures 3.4.1 to 3.4.8 in chapter 3

4.4 List of experimental series

The experiments carried out in the flume were labelled as series as seen in section 4.1 i.e. series 1.1 to 1.8 for the smooth bed flume and 2.1 to 2.8 for the rough bed flume. Each series contains a detailed explanation as seen in section 4.2 above of the pictures, graphs and tables

CHAPTER 4-DESCRIPTION AND LIST OF EXPERIMENTAL SERIES.

INVESTIGATIONS OF COMPOSITE ROUGHNESS COEFFICIENT IN A RIVER WITH LOW FLOW

involved in carrying out the experimental analyses in chapter 5. These series have been put in the appendix for better understanding. Below are the series results

4.4.1 Series 1.2 Smooth bed flume with irregularities

Table 4.4. Summary of measured depths, resistance coefficients (f and n) at given discharges for the smooth bed flume with irregularities.

Q (m ³ /h)	Q (m ³ /s)	depth	Area (m)	V(m/s)	R (m)	Sf	f	n	Re	x	$\frac{l_b}{x}$
51.4	0.014	0.068	0.065	0.210	0.059	0.001	0.063	0.018	49958	10.534	0.063
83.7	0.023	0.089	0.085	0.261	0.075	0.001	0.050	0.016	78315	9.007	0.073
106	0.029	0.104	0.099	0.283	0.085	0.001	0.049	0.017	96674	8.496	0.078
129	0.036	0.120	0.114	0.298	0.096	0.001	0.050	0.017	114285	8.161	0.081
151	0.042	0.134	0.128	0.311	0.105	0.001	0.049	0.017	130347	7.934	0.083
60.0	0.017	0.074	0.070	0.225	0.064	0.001	0.058	0.017	57681	9.969	0.066
40.0	0.011	0.060	0.057	0.185	0.053	0.001	0.071	0.018	39460	11.66	0.057
50.0	0.014	0.066	0.063	0.210	0.058	0.001	0.060	0.017	48778	10.64	0.062
70.0	0.019	0.080	0.076	0.243	0.068	0.001	0.053	0.017	66567	9.482	0.070
80.0	0.022	0.087	0.083	0.255	0.074	0.001	0.052	0.017	75129	9.121	0.072
										Ave	0.070

Note x was obtained from equation 2.42 where $R_m = R_e$

CHAPTER 4-DESCRIPTION AND LIST OF EXPERIMENTAL SERIES.

INVESTIGATIONS OF COMPOSITE ROUGHNESS COEFFICIENT IN A RIVER WITH LOW FLOW

4.4.2 Series 1.3 smooth bed flume with obstructions

Table 4.5. Summary of measured depths, resistance coefficients (f and n) at given discharges for the smooth bed flume with obstructions.

Q (m ³ /h)	Q(m ³ /s)	Depth (m)	A_{bf} (m ²)	Area (m ²)	V (m/s)	R(m)	S_f	f	n
49.6	0.014	0.080	0.00096	0.079	0.174	0.068	0.00058	0.102	0.023
71.1	0.020	0.103	0.00124	0.102	0.194	0.084	0.00058	0.102	0.024
86.8	0.024	0.122	0.00146	0.120	0.200	0.097	0.00057	0.108	0.025
108	0.030	0.143	0.00172	0.141	0.211	0.110	0.00058	0.112	0.026
126	0.035	0.165	0.00198	0.163	0.214	0.123	0.00058	0.121	0.028
60.0	0.017	0.092	0.00110	0.091	0.183	0.077	0.00058	0.103	0.024
40.0	0.011	0.070	0.00084	0.069	0.161	0.061	0.00058	0.106	0.023
50.0	0.014	0.080	0.00096	0.079	0.176	0.068	0.00058	0.100	0.023
70.0	0.019	0.103	0.00124	0.102	0.191	0.084	0.00058	0.105	0.024
80.0	0.022	0.112	0.00134	0.111	0.201	0.090	0.00058	0.102	0.024

4.4.3 Series 1.4 Smooth bed flume with Vegetation.

Table 4.6. Summary of measured depths, resistance coefficients (f and n) at given discharges for the smooth bed flume with vegetation.

Q (m ³ /h)	Q (m ³ /s)	Depth (m)	Area (m ²)	V (m/s)	R(m)	S_f	f	n
32.5	0.0090	0.0600	0.0588	0.154	0.053	0.000576	0.101	0.02192
45.0	0.0125	0.0680	0.0666	0.188	0.059	0.000583	0.076	0.01943
56.2	0.0156	0.0780	0.0764	0.204	0.066	0.000579	0.072	0.01927
65.1	0.0181	0.0850	0.0833	0.217	0.071	0.000574	0.068	0.01896
85.0	0.0236	0.1000	0.0980	0.241	0.082	0.000579	0.064	0.01880
40.0	0.0111	0.0640	0.0627	0.177	0.056	0.000578	0.080	0.01977
50.0	0.0139	0.0720	0.0706	0.197	0.062	0.000578	0.072	0.01906
60.0	0.0167	0.0800	0.0784	0.213	0.068	0.000577	0.068	0.01875
70.0	0.0194	0.0880	0.0862	0.225	0.073	0.000577	0.065	0.01867
80.0	0.0222	0.0960	0.0941	0.236	0.079	0.000578	0.064	0.01873

CHAPTER 4-DESCRIPTION AND LIST OF EXPERIMENTAL SERIES.

INVESTIGATIONS OF COMPOSITE ROUGHNESS COEFFICIENT IN A RIVER WITH LOW FLOW

4.4.4 Series 1.5 Smooth bed flume with combination of irregularities and obstructions.

Table 4.7. Summary of measured depths, resistance coefficients f and n) at given discharges for the smooth bed flume with irregularities and obstructions.

Q(m ³ /h)	Q(m ³ /s)	Depth(m)	Area(m ²)	V(m/s)	R(m)	Sf	f	n
43.5	0.012	0.098	0.092	0.131	0.077	0.00058	0.203	0.033
66.9	0.019	0.128	0.120	0.155	0.096	0.00058	0.182	0.033
89.6	0.025	0.154	0.144	0.172	0.110	0.00058	0.169	0.032
108	0.030	0.181	0.170	0.177	0.125	0.00058	0.180	0.034
21.6	0.006	0.073	0.068	0.088	0.059	0.00058	0.348	0.042
60.0	0.017	0.118	0.111	0.151	0.090	0.00058	0.179	0.032
40.0	0.011	0.094	0.088	0.126	0.074	0.00058	0.212	0.034
50.0	0.014	0.106	0.099	0.140	0.082	0.00058	0.191	0.033
70.0	0.019	0.131	0.123	0.158	0.097	0.00058	0.176	0.032
80.0	0.022	0.146	0.137	0.162	0.106	0.00058	0.183	0.033

4.4.5 Series 1.6 Smooth bed flume with combination of irregularities and vegetation.

Table 4.8. Summary of measured depths, resistance coefficients (f and n) at given discharges for the smooth bed flume with irregularities and vegetation.

Q(m ³ /h)	Q(m ³ /s)	Depth(m)	Area(m ²)	V(m/s)	R(m)	Sf	f	n
43.7	0.012	0.072	0.067	0.180	0.059	0.00058	0.082	0.020
60.0	0.017	0.090	0.084	0.199	0.071	0.00057	0.081	0.021
74.6	0.021	0.108	0.101	0.206	0.083	0.00058	0.089	0.022
99.3	0.028	0.134	0.124	0.222	0.098	0.00058	0.091	0.023
116	0.032	0.155	0.144	0.224	0.110	0.00058	0.099	0.025
60.0	0.017	0.091	0.085	0.197	0.072	0.00058	0.084	0.021
40.0	0.011	0.068	0.063	0.176	0.056	0.00058	0.082	0.020
50.0	0.014	0.080	0.074	0.187	0.064	0.00058	0.084	0.021
70.0	0.019	0.102	0.095	0.205	0.079	0.00058	0.085	0.022
80.0	0.022	0.113	0.105	0.211	0.086	0.00058	0.087	0.022

CHAPTER 4-DESCRIPTION AND LIST OF EXPERIMENTAL SERIES.

INVESTIGATIONS OF COMPOSITE ROUGHNESS COEFFICIENT IN A RIVER WITH LOW FLOW

4.4.6 Series 1.7 Smooth bed flume with combination of obstructions and vegetation.

Table 4.9. Summary of measured depths, resistance coefficients (f and n) at given discharges for the smooth bed flume with vegetation and obstructions.

Q(m ³ /h)	Q(m ³ /s)	Depth(m)	Area(m ²)	V(m/s)	R(m)	S_f	f	n
58.0	0.016	0.122	0.118	0.137	0.095	0.00059	0.234	0.037
50.9	0.014	0.105	0.101	0.140	0.084	0.00058	0.195	0.033
65.4	0.018	0.134	0.129	0.140	0.102	0.00058	0.234	0.037
81.1	0.023	0.166	0.160	0.140	0.120	0.00058	0.280	0.042
92.9	0.026	0.197	0.190	0.136	0.137	0.00058	0.336	0.047
60.0	0.017	0.122	0.118	0.141	0.095	0.00058	0.217	0.036
40.0	0.011	0.079	0.076	0.145	0.066	0.00058	0.142	0.027
50.0	0.014	0.102	0.099	0.141	0.082	0.00058	0.188	0.032
70.0	0.019	0.144	0.139	0.139	0.108	0.00058	0.253	0.039
80.0	0.022	0.168	0.163	0.137	0.122	0.00058	0.296	0.043

4.4.7 Series 1.8 Smooth bed flume with a combination of irregularities, obstructions and vegetation.

Table 4.10. Summary of measured depths, resistance coefficients (f and n) at given discharges for the smooth bed flume with irregularities, obstructions and vegetation

Q(m ³ /h)	Q(m ³ /s)	Depth(m)	Area(m ²)	V(m/s)	R(m)	S_f	f	n
41.4	0.012	0.109	0.100	0.115	0.082	0.00058	0.279	0.039
52.5	0.015	0.141	0.129	0.113	0.101	0.00058	0.358	0.046
63.6	0.018	0.174	0.160	0.111	0.119	0.00058	0.439	0.052
66.9	0.019	0.186	0.171	0.109	0.124	0.00058	0.479	0.055
69.8	0.019	0.193	0.177	0.110	0.128	0.00058	0.481	0.056
60.0	0.017	0.164	0.151	0.111	0.113	0.00058	0.420	0.051
40.0	0.011	0.104	0.095	0.116	0.079	0.00058	0.265	0.038
50.0	0.014	0.134	0.123	0.113	0.097	0.00058	0.345	0.045
70.0	0.019	0.194	0.178	0.109	0.128	0.00058	0.489	0.056
80.0	0.022	0.223	0.205	0.109	0.142	0.00058	0.545	0.060

CHAPTER 4-DESCRIPTION AND LIST OF EXPERIMENTAL SERIES.

INVESTIGATIONS OF COMPOSITE ROUGHNESS COEFFICIENT IN A RIVER WITH LOW FLOW

4.4.8 Series 2.1 rough bed flume

4.11. Summary of measured depths, resistance coefficients (f and n) at given discharges for the rough bed flume only.

Q (m ³ /h)	Q (m ³ /s)	Depth (m)	De(m)	Area (m ²)	V(m/s)	R (m)	S_f	f	n
32.6	0.009	0.081	0.065	0.065	0.139	0.058	0.00059	0.157	0.028
45.0	0.013	0.095	0.079	0.079	0.159	0.068	0.00058	0.142	0.028
54.3	0.015	0.104	0.088	0.088	0.172	0.075	0.00058	0.134	0.028
65.5	0.018	0.113	0.097	0.097	0.187	0.081	0.00058	0.126	0.027
78.8	0.022	0.124	0.108	0.108	0.203	0.089	0.00058	0.119	0.027
60.0	0.017	0.108	0.092	0.092	0.181	0.078	0.00058	0.128	0.027
40.0	0.011	0.090	0.074	0.074	0.150	0.064	0.00058	0.149	0.028
50.0	0.014	0.098	0.082	0.082	0.169	0.070	0.00058	0.130	0.027
70.0	0.019	0.116	0.100	0.100	0.194	0.083	0.00058	0.120	0.027
80.0	0.022	0.126	0.110	0.110	0.202	0.090	0.00058	0.123	0.027

4.4.9 Series 2.2 rough bed flume with irregularities.

Table 4.12. Summary of measured depths, resistance coefficients (f and n) at given discharges for the rough bed flume with irregularities.

Q (m ³ /h)	Q (m ³ /s)	Depth(m)	Effective Depth(m)	A_{bf} (m ²)	Area(m ²)	V(m/s)	R(m)	S_f	f	n
33.5	0.009	0.085	0.069	0.0037	0.0667	0.140	0.059	0.00058	0.161	0.029
45.0	0.013	0.099	0.083	0.0045	0.0805	0.155	0.069	0.00058	0.155	0.029
57.6	0.016	0.113	0.097	0.0053	0.0944	0.169	0.079	0.00057	0.151	0.030
68.3	0.019	0.123	0.107	0.0058	0.1041	0.182	0.086	0.00058	0.147	0.030
82.2	0.023	0.136	0.120	0.0066	0.1171	0.195	0.095	0.00058	0.143	0.030
40.0	0.011	0.093	0.077	0.0042	0.0749	0.148	0.065	0.00058	0.158	0.0293
50.0	0.014	0.103	0.087	0.0047	0.0846	0.164	0.072	0.00058	0.146	0.0287
60.0	0.017	0.114	0.098	0.0053	0.0953	0.175	0.080	0.00058	0.145	0.0292
70.0	0.019	0.124	0.108	0.0059	0.1051	0.185	0.087	0.00058	0.143	0.0294
80.0	0.022	0.135	0.119	0.0065	0.1131	0.197	0.092	0.00058	0.139	0.0295

CHAPTER 4-DESCRIPTION AND LIST OF EXPERIMENTAL SERIES.

INVESTIGATIONS OF COMPOSITE ROUGHNESS COEFFICIENT IN A RIVER WITH LOW FLOW

4.4.10 Series 2.3 rough bed flume with obstructions.

Table 4.13. Summary of measured depths, resistance coefficients (f and n) at given discharges for the rough bed flume with obstructions.

Q (m ³ /h)	Q (m ³ /s)	Depth (m)	Effective Depth(m)	A_{bf} (m ²)	Area (m ²)	V(m/s)	R(m)	S_f	f	n
32.5	0.009	0.089	0.073	0.0012	0.072	0.125	0.063	0.00057	0.207	0.033
46.5	0.013	0.107	0.091	0.0015	0.090	0.144	0.076	0.00058	0.200	0.034
55.8	0.016	0.121	0.105	0.0017	0.104	0.150	0.086	0.00058	0.212	0.036
71.1	0.020	0.138	0.122	0.0020	0.121	0.164	0.097	0.00058	0.207	0.036
85.3	0.024	0.157	0.141	0.0022	0.139	0.170	0.109	0.00058	0.220	0.038
60.0	0.017	0.124	0.108	0.0017	0.107	0.156	0.088	0.00058	0.202	0.035
40.0	0.011	0.100	0.084	0.0013	0.083	0.134	0.071	0.00058	0.214	0.035
50.0	0.014	0.112	0.096	0.0015	0.095	0.146	0.080	0.00058	0.205	0.035
70.0	0.019	0.138	0.122	0.0020	0.121	0.161	0.097	0.00058	0.214	0.037
80.0	0.022	0.150	0.134	0.0021	0.133	0.168	0.105	0.00058	0.217	0.038

4.4.11 Series 2.4 Rough bed flume with vegetation

Table 4.14. Summary of measured depths, resistance coefficients (f and n) at given discharges for the rough bed flume with vegetation.

Q(m ³ /h)	Q(m ³ /s)	Depth(m)	Effective Depth(m)	Area(m ²)	V(m/s)	R(m)	S_f	f	n
32.5	0.009	0.087	0.071	0.069	0.131	0.061	0.00057	0.1846	0.031
45.0	0.013	0.100	0.084	0.083	0.151	0.071	0.00059	0.1697	0.031
56.2	0.016	0.114	0.098	0.096	0.163	0.080	0.00058	0.1651	0.031
65.1	0.018	0.124	0.108	0.106	0.171	0.087	0.00058	0.1663	0.032
85.0	0.024	0.137	0.121	0.119	0.199	0.096	0.00058	0.1400	0.030
60.0	0.017	0.116	0.100	0.098	0.170	0.082	0.00058	0.1567	0.030
40.0	0.011	0.096	0.080	0.078	0.142	0.068	0.00058	0.1810	0.032
50.0	0.014	0.106	0.090	0.088	0.157	0.075	0.00058	0.1646	0.031
70.0	0.019	0.124	0.108	0.106	0.184	0.087	0.00058	0.1453	0.030
80.0	0.022	0.135	0.119	0.117	0.191	0.095	0.00058	0.1489	0.031

CHAPTER 4-DESCRIPTION AND LIST OF EXPERIMENTAL SERIES.
INVESTIGATIONS OF COMPOSITE ROUGHNESS COEFFICIENT IN A RIVER WITH LOW FLOW

4.4.12 Series 2.5. Rough bed flume with combination of irregularities and obstructions.

Table 4.15. Summary of measured depths, resistance coefficients (f and n) at given discharges for the rough bed flume with obstructions and irregularities.

Q(m ³ /h)	Q(m ³ /s)	Depth(m)	De(m)	Area(m ²)	V(m/s)	R(m)	S_f	f	n
31.0	0.009	0.095	0.079	0.074	0.116	0.064	0.00058	0.266	0.038
41.9	0.012	0.112	0.096	0.090	0.129	0.076	0.00058	0.264	0.039
52.7	0.015	0.131	0.115	0.108	0.136	0.089	0.00058	0.283	0.042
63.5	0.018	0.148	0.132	0.123	0.143	0.099	0.00058	0.292	0.044
74.4	0.021	0.166	0.150	0.141	0.147	0.110	0.00058	0.319	0.046
60.0	0.017	0.142	0.126	0.118	0.141	0.096	0.00058	0.289	0.043
40.0	0.011	0.110	0.094	0.088	0.126	0.075	0.00058	0.270	0.040
50.0	0.014	0.126	0.110	0.103	0.135	0.086	0.00058	0.277	0.041
70.0	0.019	0.158	0.142	0.133	0.146	0.105	0.00058	0.304	0.045
80.0	0.022	0.174	0.158	0.148	0.150	0.114	0.00058	0.321	0.047

4.4.13 Series 2.6 Rough bed flume with combination of irregularities and vegetation.

Table 4.16. Summary of measured depths, resistance coefficients (f and n) at given discharges for the rough bed flume with vegetation and irregularities.

Q(m ³ /h)	Q(m ³ /s)	Depth(m)	Effective Depth(m)	Area(m ²)	V(m/s)	R(m)	S_f	f	n
35.7	0.010	0.100	0.084	0.078	0.127	0.068	0.00057	0.234	0.036
48.0	0.013	0.114	0.098	0.091	0.146	0.077	0.00058	0.208	0.035
60.5	0.017	0.131	0.115	0.107	0.157	0.088	0.00058	0.211	0.036
72.9	0.020	0.146	0.130	0.121	0.168	0.097	0.00058	0.209	0.037
85.0	0.024	0.160	0.144	0.134	0.176	0.106	0.00058	0.213	0.038
60.0	0.017	0.130	0.114	0.106	0.157	0.087	0.00058	0.209	0.036
40.0	0.011	0.106	0.090	0.084	0.133	0.072	0.00058	0.232	0.036
50.0	0.014	0.118	0.102	0.095	0.146	0.080	0.00058	0.216	0.036
70.0	0.019	0.142	0.126	0.117	0.166	0.095	0.00058	0.208	0.036
80.0	0.022	0.154	0.138	0.128	0.173	0.102	0.00058	0.209	0.037

CHAPTER 4-DESCRIPTION AND LIST OF EXPERIMENTAL SERIES.

INVESTIGATIONS OF COMPOSITE ROUGHNESS COEFFICIENT IN A RIVER WITH LOW FLOW

4.4.14 Series 2.7. Rough bed flume with combination of obstruction and vegetation

Table 4.17. Summary of measured depths, resistance coefficients (f and n) at given discharges for the rough bed flume with obstructions and vegetation

Q(m ³ /h)	Q(m ³ /s)	Depth(m)	Effective Depth(m)	Area(m ²)	V(m/s)	R(m)	S_f	f	n
31.0	0.009	0.095	0.079	0.0764	0.113	0.066	0.00059	0.285	0.039
45.0	0.013	0.115	0.099	0.0957	0.131	0.080	0.00058	0.263	0.039
57.4	0.016	0.137	0.121	0.1167	0.137	0.095	0.00058	0.294	0.043
69.8	0.019	0.157	0.141	0.1364	0.142	0.107	0.00058	0.318	0.046
82.2	0.023	0.178	0.162	0.1570	0.145	0.119	0.00058	0.347	0.049
60.0	0.017	0.142	0.126	0.1220	0.137	0.098	0.00058	0.307	0.044
40.0	0.011	0.108	0.092	0.0891	0.125	0.076	0.00058	0.269	0.039
50.0	0.014	0.123	0.107	0.1036	0.134	0.086	0.00058	0.271	0.040
70.0	0.019	0.155	0.139	0.1346	0.145	0.106	0.00058	0.303	0.045
80.0	0.022	0.174	0.158	0.1529	0.145	0.117	0.00058	0.340	0.048

4.4.15 Series 2.8 Rough bed flume with combination of irregularities, obstruction and vegetation.

Table 4.18. Summary of measured depths, resistance coefficients (f and n) at given discharges for the rough bed flume with obstructions, irregularities and vegetation.

Q(m ³ /h)	Q(m ³ /s)	Depth(m)	Effective Depth(m)	Area (m ²)	V (m/s)	R(m)	S_f	f	n
27.9	0.008	0.101	0.085	0.078	0.100	0.067	0.00057	0.382	0.046
37.2	0.010	0.122	0.106	0.098	0.106	0.082	0.00058	0.428	0.051
45.0	0.013	0.142	0.126	0.116	0.108	0.094	0.00058	0.492	0.056
55.7	0.015	0.164	0.148	0.136	0.114	0.107	0.00058	0.526	0.060
71.3	0.020	0.192	0.176	0.162	0.123	0.122	0.00058	0.534	0.062
60.0	0.017	0.171	0.155	0.142	0.117	0.111	0.00058	0.512	0.059
40.0	0.011	0.128	0.112	0.103	0.108	0.085	0.00058	0.435	0.052
50.0	0.014	0.150	0.134	0.123	0.113	0.099	0.00058	0.478	0.056
70.0	0.019	0.192	0.176	0.162	0.120	0.122	0.00058	0.553	0.063
80.0	0.022	0.213	0.197	0.181	0.123	0.133	0.00058	0.593	0.066

**CHAPTER 4-DESCRIPTION AND LIST OF EXPERIMENTAL SERIES.
INVESTIGATIONS OF COMPOSITE ROUGHNESS COEFFICIENT IN A RIVER WITH
LOW FLOW**
