International Conference on Engineering and Ecohydrology for Fish Passage

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Jun 21st, 4:45 PM - 5:00 PM

Fish Passage Studies III: Flow and Turbulence Structure in Brush Fish Pass

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Flow and turbulence structure in brush fish pass

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Advantages of Brush Fish Pass

1) Vibrations of Bristles: Guidance for Fishes and Favorable Hydraulic Conditions

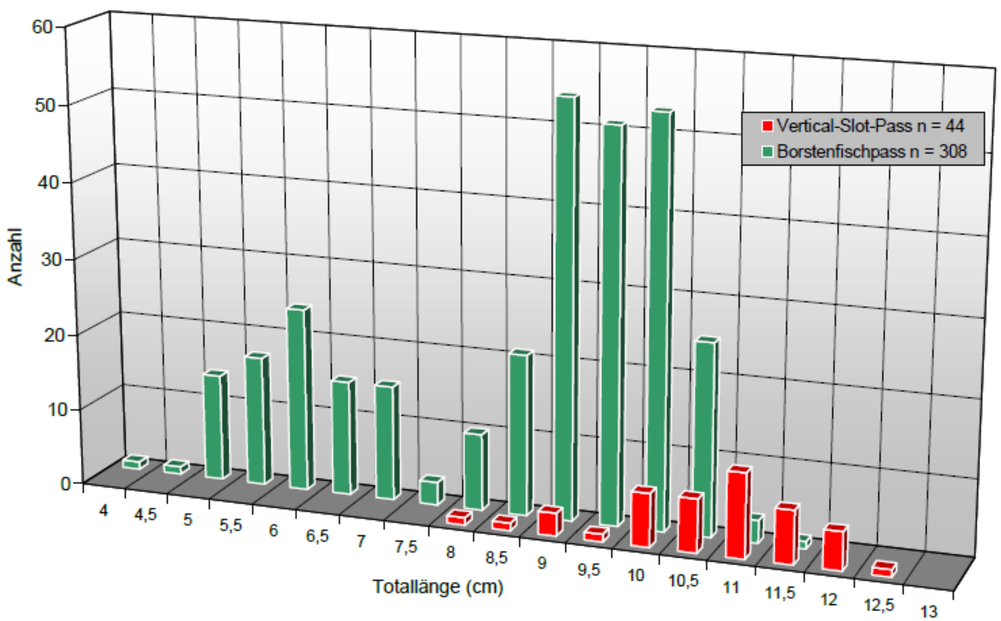
2) Suitable for Small and Weak Swimming Capacity Fish

3) Social Benefit: Passage of Canoes

Shared Value

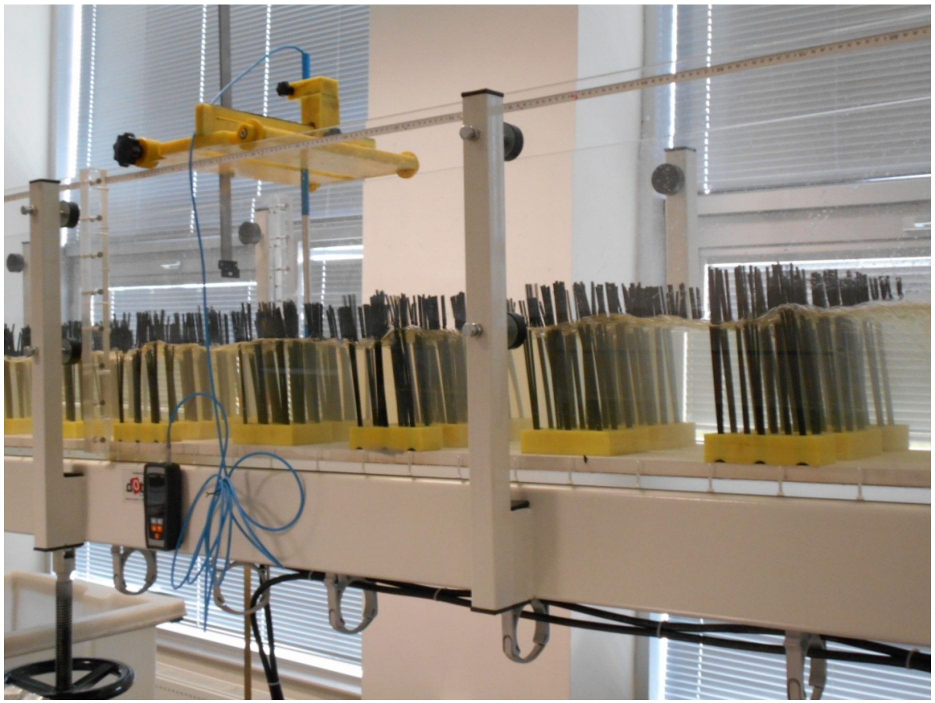
Fish Monitoring Studies in Brush Fish Pass : Spreewald, Berlin

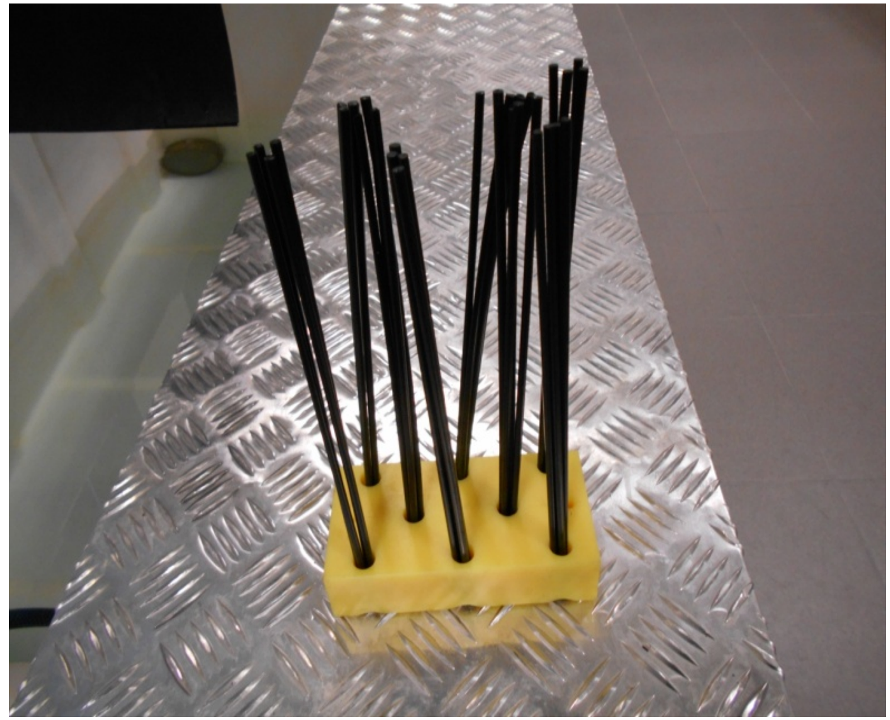
UNESCO Biosphere Reserve



Comparison of Fish Length Distributions in Brush and Vertical Slot Passes

Physical Model of Brush Fish Pass
Scale=1:2 (Froude Similarity)





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Flow Resistance of Brush Elements

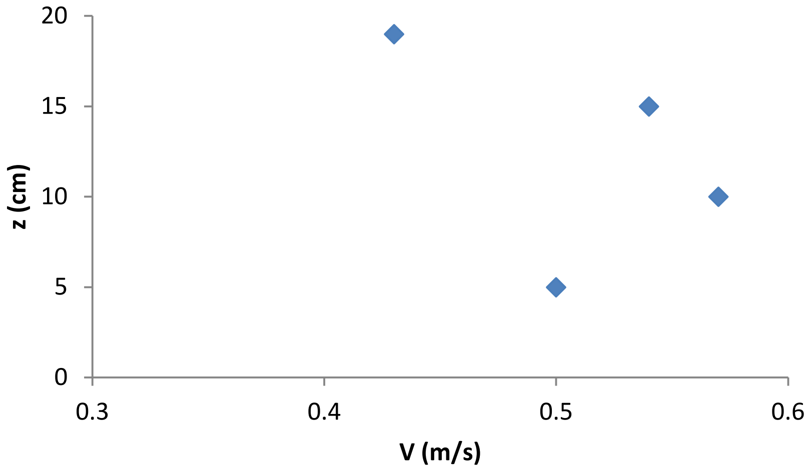
$$f = fun\left(\frac{d}{h}; A_w; S_o; Layout\right)$$

Point Velocity Distributions

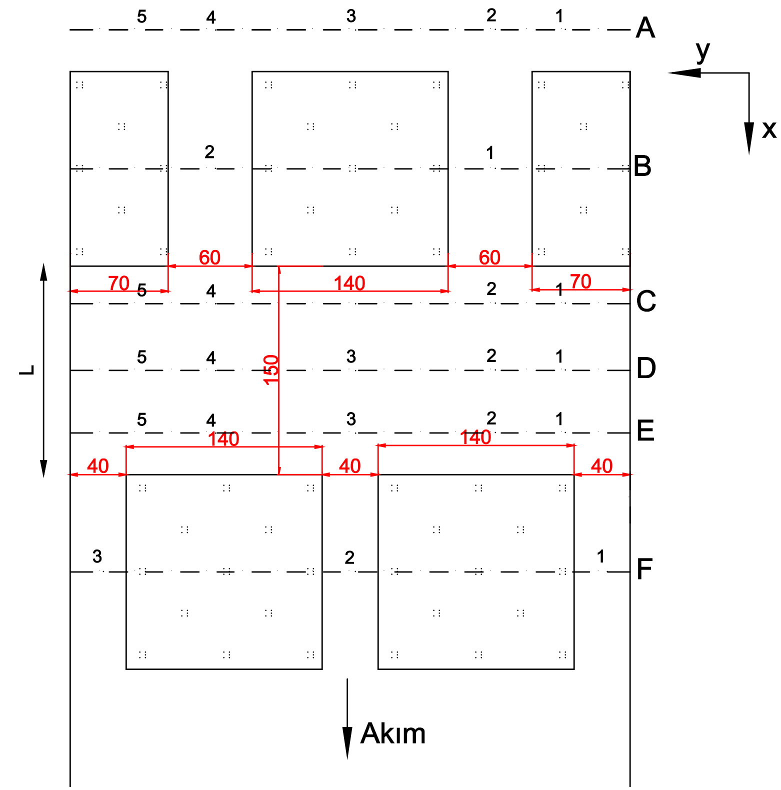
Section D

Point	y (cm)	z (cm)	V (m/s)
V_{11}	5	0.5	0.24
V_{12}	5	5	0.37
V_{13}	5	10	0.33
V_{14}	5	15	0.39
V_{15}	5	19	0.3
V_{21}	10	0.5	0.43
V_{22}	10	5	0.5
V_{23}	10	10	0.57
V_{24}	10	15	0.54
V_{25}	10	19	0.43
V_{31}	20	0.5	0.08
V_{32}	20	5	0.3
V_{33}	20	10	0.34
V_{34}	20	15	0.33
V_{35}	20	19	0.24
V_{41}	30	0.5	0.4
V_{42}	30	5	0.52
V_{43}	30	10	0.57
V_{44}	30	15	0.53
V_{45}	30	19	0.3
V_{51}	35	0.5	0.45
V_{52}	35	5	0.25
V_{53}	35	10	0.25
V_{54}	35	15	0.3
V_{55}	35	19	0.26

S_o	4%	A_w (m^2/m^2)	L=15 cm	Q (l/s)	27.3

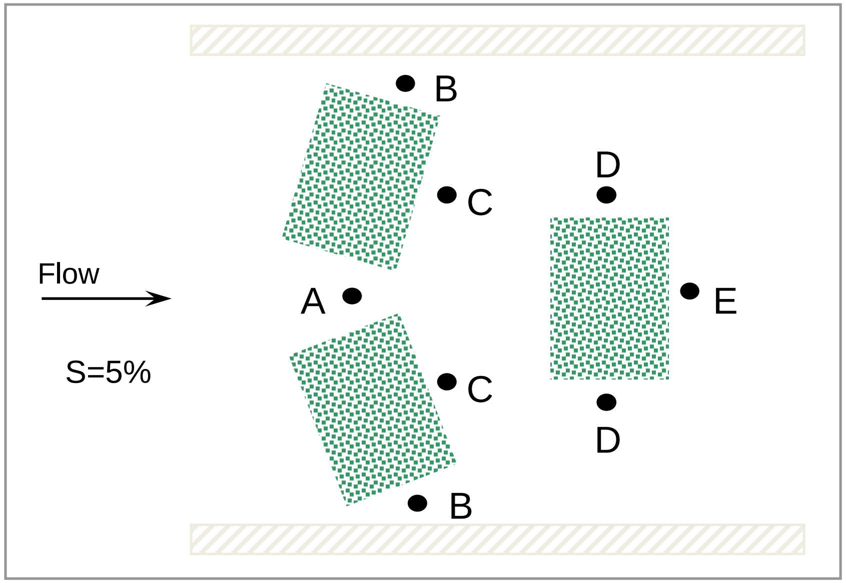


Typical Velocity Profile



Field Measurments

Data Source: Mosch (2007)



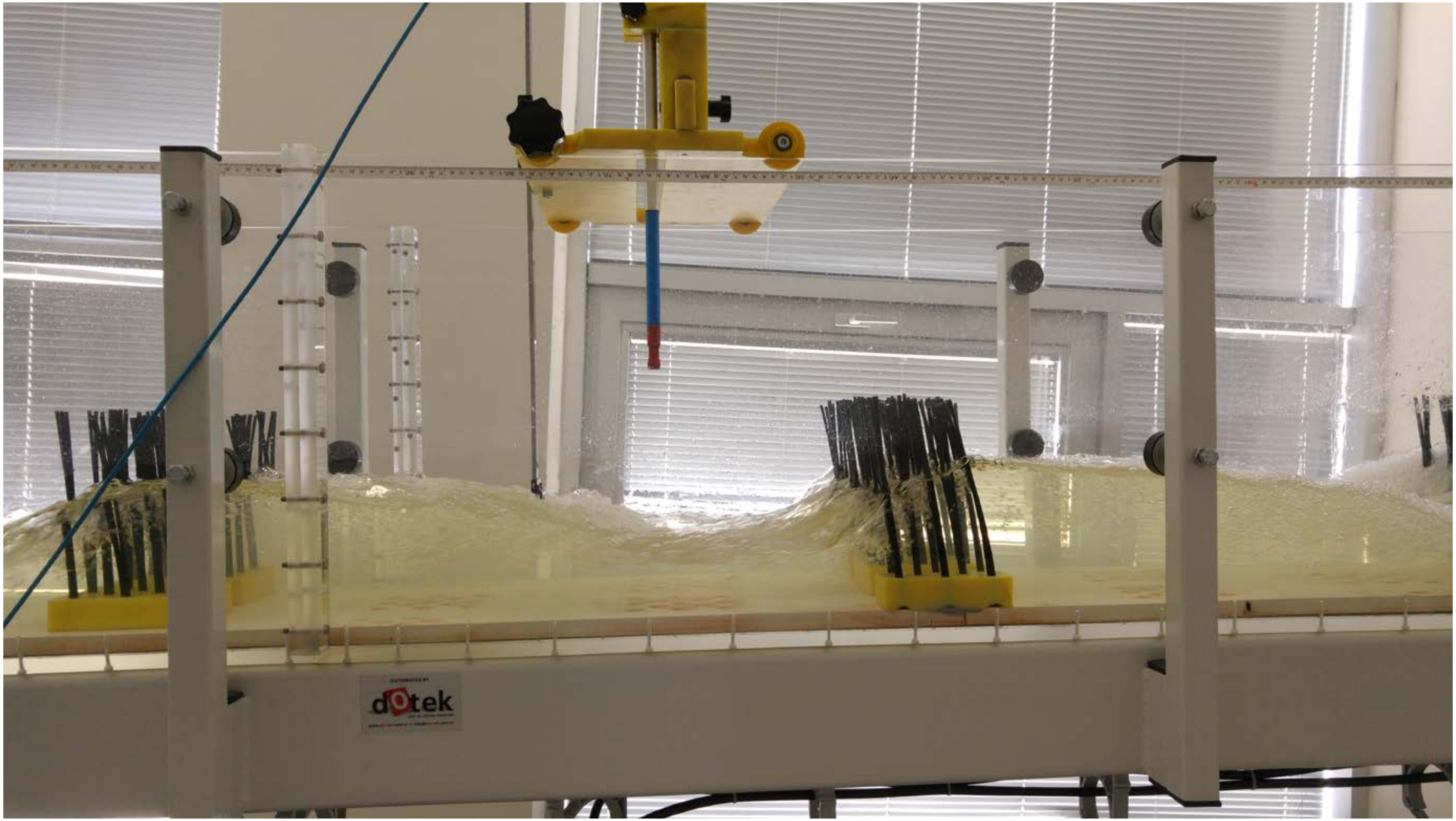
Messpunkt	v_{avr} [m/s]	v_{min} [m/s]	v_{max} [m/s]
A	0,67	0,59	0,74
D	0,51	0,51	0,39
B	0,30	0,08	0,54
C + E	0,11	0,04	0,21

Experimental Test Results

Test No	S_o	Q (l/s)	d (mm)	d/h	A_w (m^2/m^2)	V (m/s)	f	Re	Fr	ΔP (W/m^3)
1	2%	8.5	111.5	0.48	0.016	0.19	3.10	5.46E+04	0.18	37.4
2	2%	15.1	153.7	0.67	0.016	0.25	2.26	8.54E+04	0.20	48.2
3	2%	18.3	173.5	0.75	0.016	0.26	2.10	9.80E+04	0.20	51.7
4	2%	21.2	192.5	0.84	0.016	0.28	2.03	1.08E+05	0.20	54.0
5	2%	24.9	209.8	0.91	0.016	0.30	1.83	1.22E+05	0.21	58.2
6	2%	27.2	225.9	0.98	0.016	0.30	1.84	1.28E+05	0.20	59.1
7	4%	8.5	93.3	0.41	0.016	0.23	3.85	5.80E+04	0.24	89.4
8	4%	15.1	131.5	0.57	0.016	0.29	3.02	9.11E+04	0.25	112.7
9	4%	18.3	150.0	0.65	0.016	0.30	2.89	1.05E+05	0.25	119.7
10	4%	21.2	169.6	0.74	0.016	0.31	2.95	1.15E+05	0.24	122.6
11	4%	24.9	186.0	0.81	0.016	0.33	2.70	1.29E+05	0.25	131.3
12	4%	27.2	201.7	0.88	0.016	0.34	2.77	1.35E+05	0.24	132.3
13	6%	8.5	83.9	0.36	0.016	0.25	4.33	5.99E+04	0.28	149.2
14	6%	15.1	117.3	0.51	0.016	0.32	3.36	9.52E+04	0.30	189.4
15	6%	18.3	135.2	0.59	0.016	0.34	3.32	1.09E+05	0.29	199.1
16	6%	21.2	151.1	0.66	0.016	0.35	3.29	1.21E+05	0.29	206.5
17	6%	24.9	168.0	0.73	0.016	0.37	3.13	1.35E+05	0.29	218.1
18	6%	27.2	182.3	0.79	0.016	0.37	3.23	1.42E+05	0.28	219.5

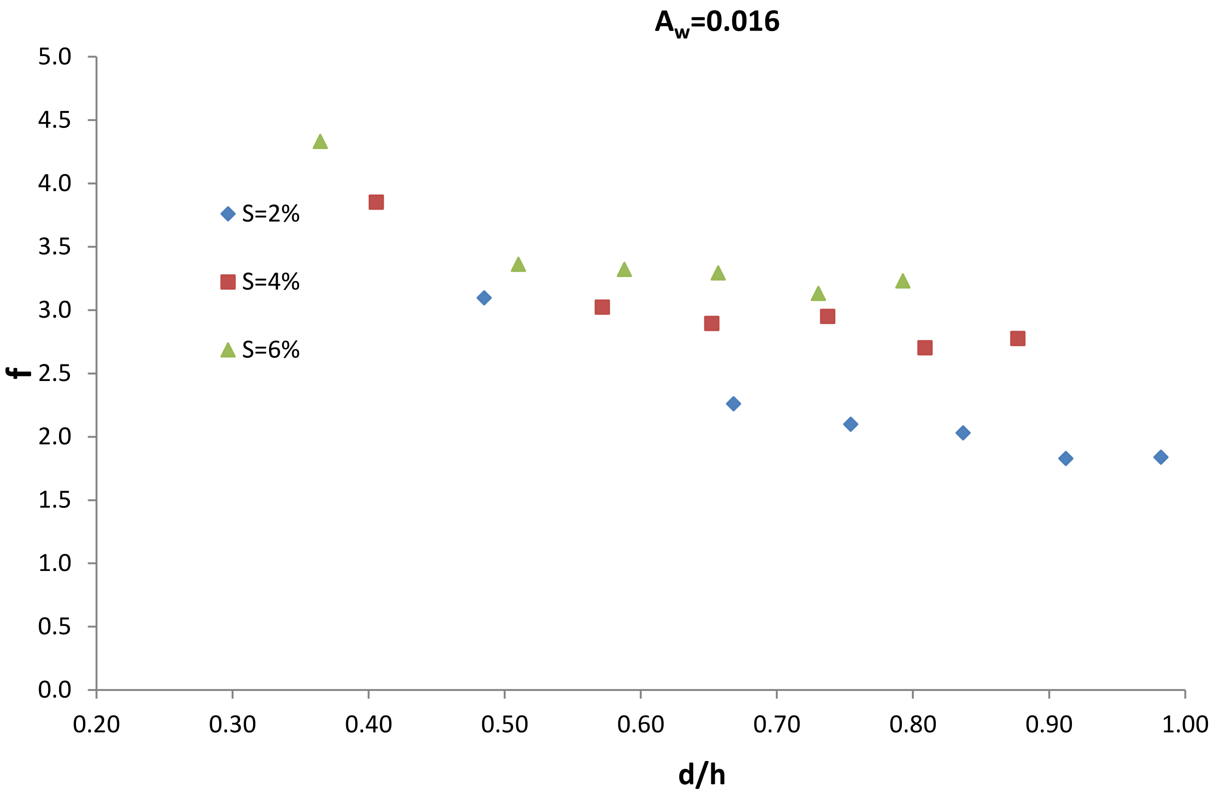
$$A_w = \frac{n_b \pi D_b^{\,2}}{4BL} \qquad f = \frac{8S_o R g}{V^2} \qquad Fr = \frac{V}{\sqrt{dg}} \qquad \Delta P = \frac{\gamma Q S_o}{Bd}$$

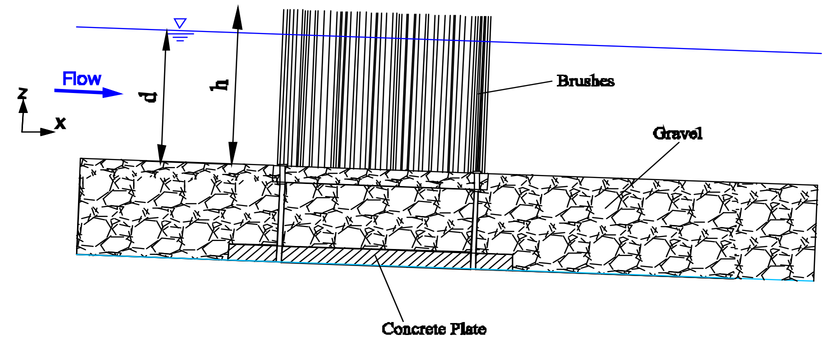
Tumbling Flow Regime

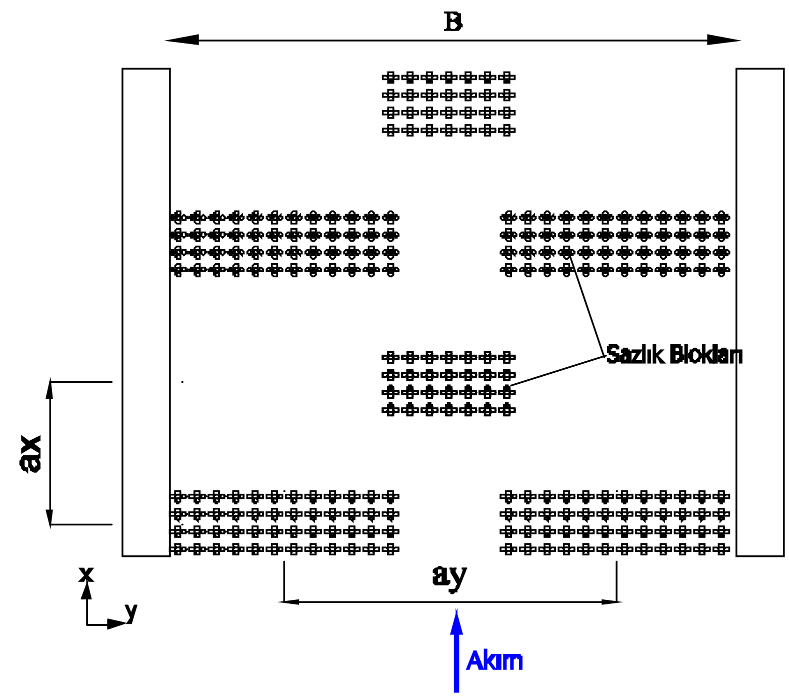


L=72 cm >5L_x (Spacing Between Brush Bars)

Friction Factor

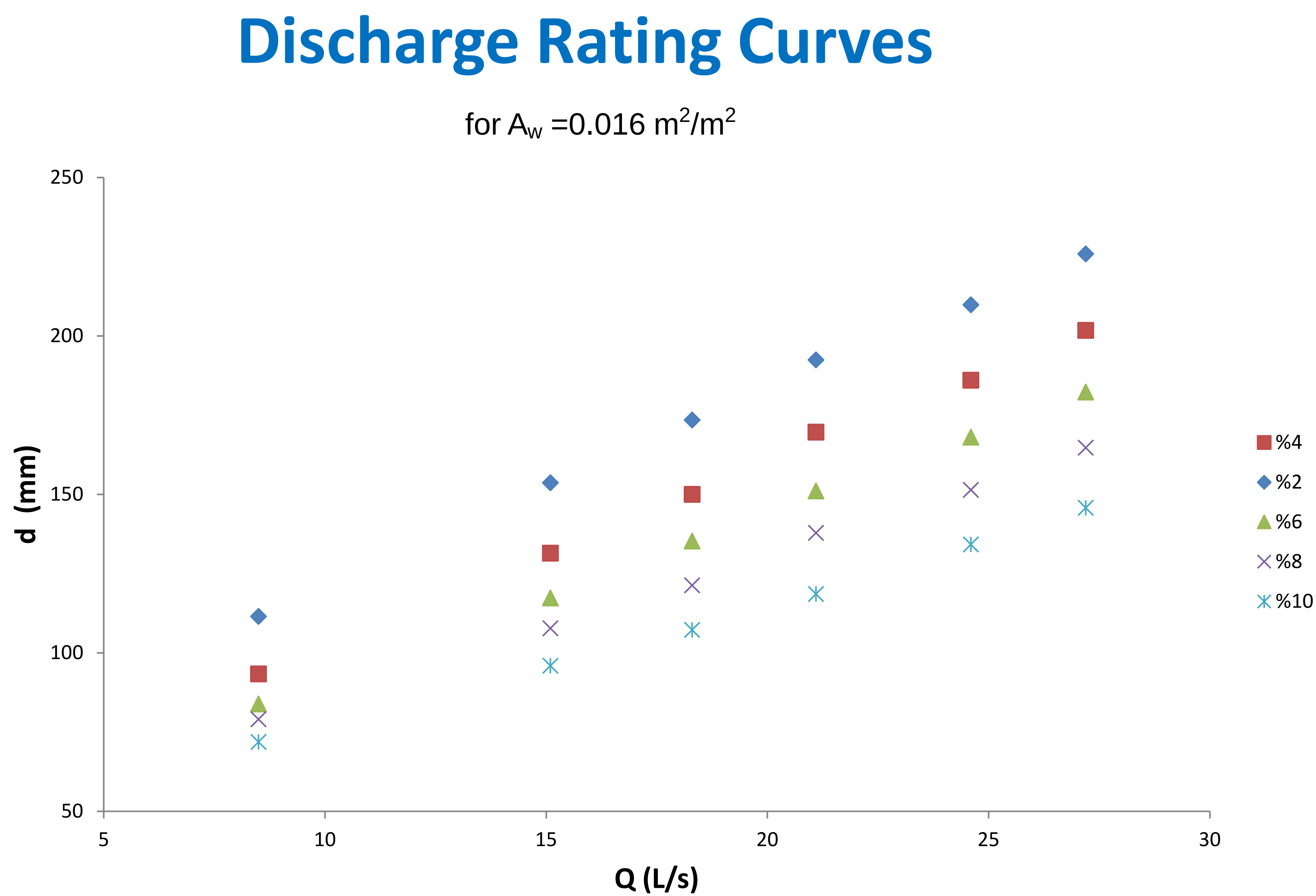






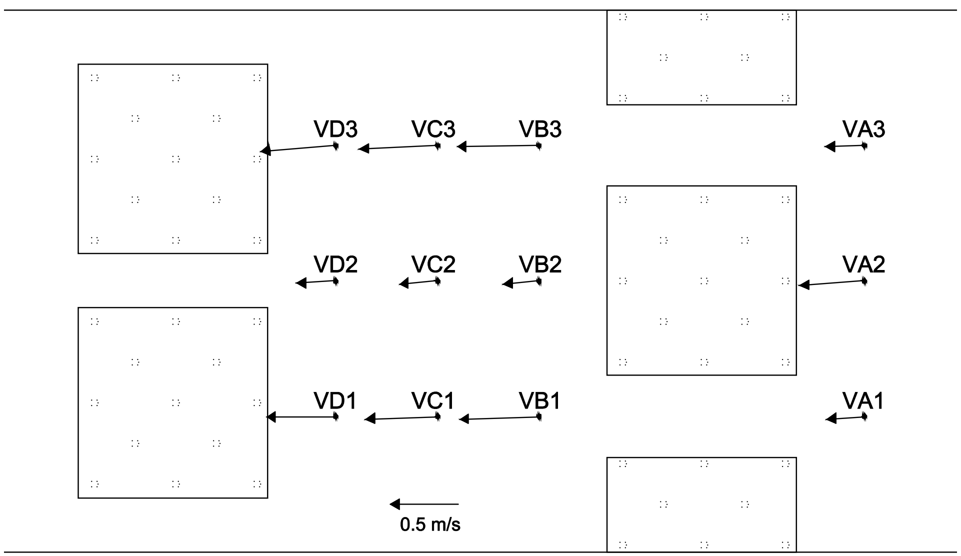
$$f = fun\left(\frac{d}{h}; A_w; S_o; Layout\right)$$

$$\frac{1}{\sqrt{f}} = c_1(d/h) + c_2$$

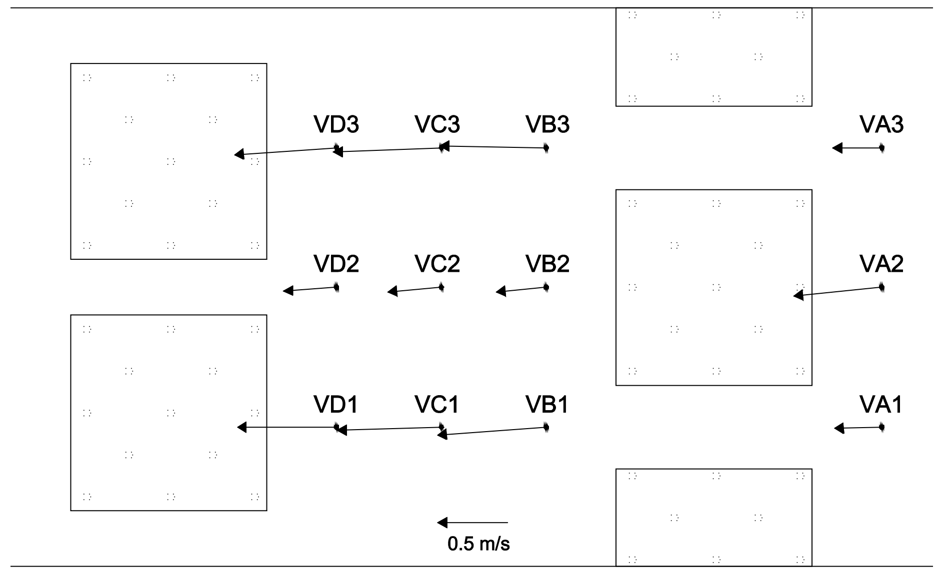

Discharge Rating Curves
for A_w =0.016 m^2/m^2
d (mm)
250
200
150
100
50
5
10
15
20
25
30
Q (L/s)
%4
%2
%6
%8
%10

Velocity Field Around Brush Blocks

(Q=27 L/s, L=35 cm)

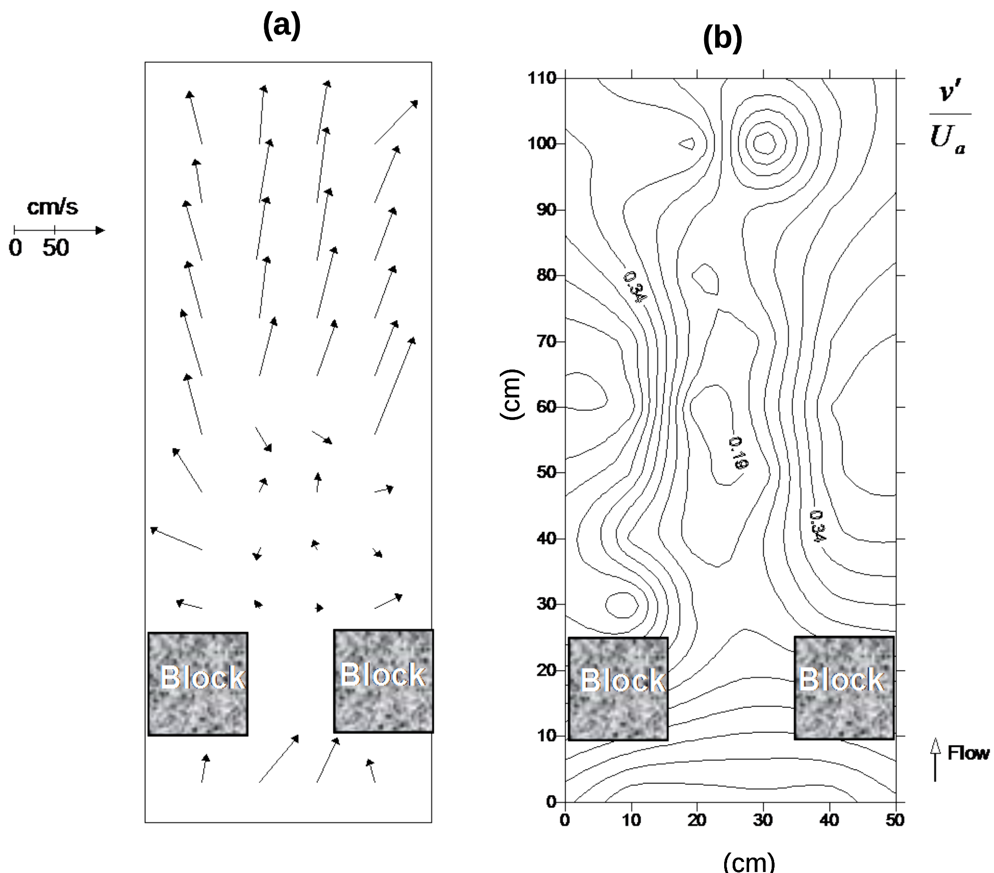


So=2%



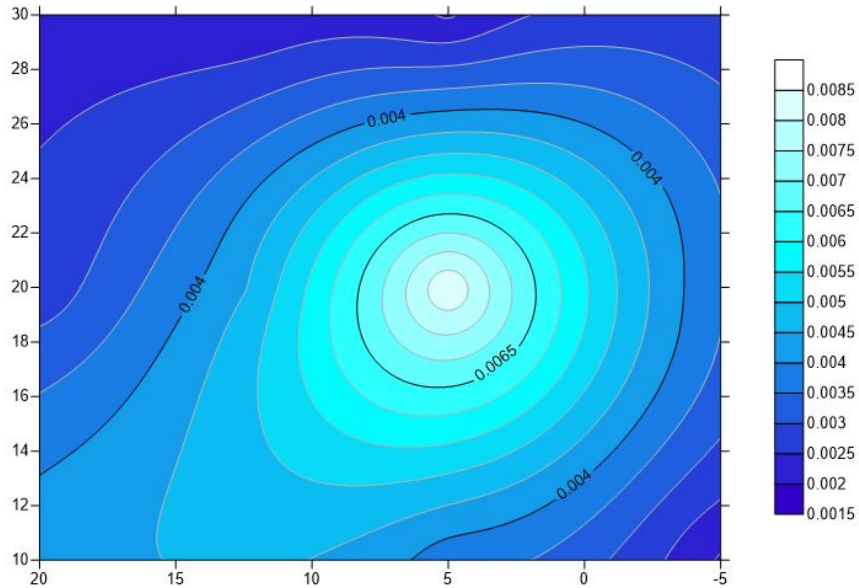
So=6%

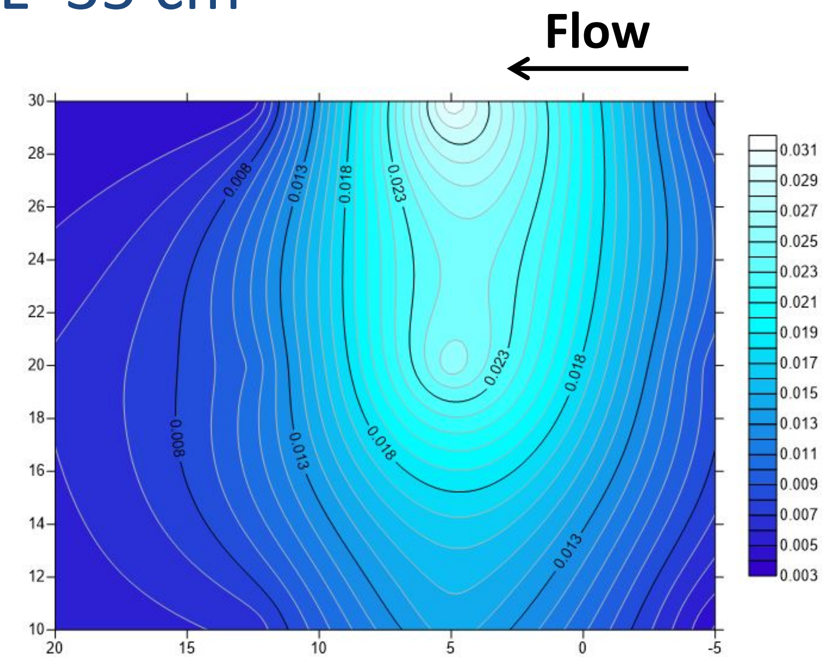
Velocity Field around Concrete Blocks



Top view of some flow characteristics around the simple habitat structures through the measurement area. Measurements were employed at central flow depths. (a) velocity vectors; (b) contour lines of vertical turbulence intensity: relative submergence=0.8 , blockage ratio=0.6, q=0.8 m^2/s (unit discharge)

Turbulent Kinetic Energy (m^2/s^2) Distribution Between Brush Bars, L=35 cm

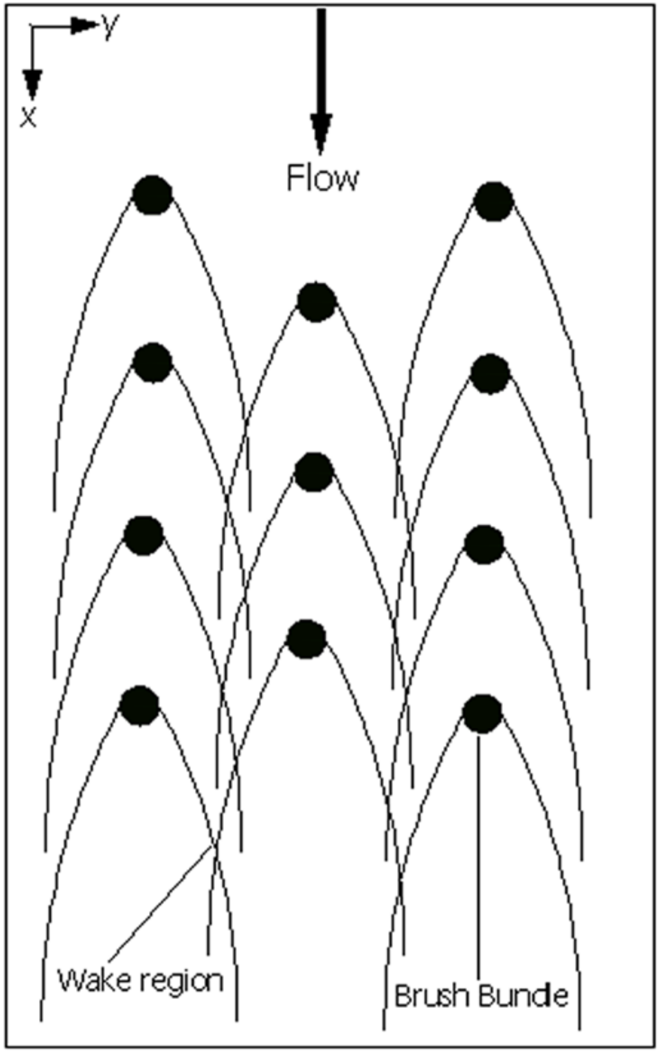




So=2% Plan View **So=6%**

$$\varepsilon = 0.168 \times \frac{k^{3/2}}{L}$$

Energy Dissipation: Vibration of Bristels



$$St = \frac{fD}{V}$$

Thank you for your kind interest

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