*Water Resources Research*

Supporting Information for

# Hydrodynamics of steep streams with planar coarse-grained beds: Turbulence, flow resistance, and implications for sediment transport.

Michael P. Lamb*, Fanny Brun and Brian M. Fuller

Division of Geological and Planetary Sciences, California Institute of Technology, Pasadena, CA, 91125

**Contents of this file**

Table S1. Measurements from all experiments.

| Experiment number | Bed slope, $S$ | Discharge, $Q$ ($m^3/s$) | Subsurface discharge, $Q_{sub}$ ($m^3/s$) † | Depth-averaged velocity, $U_{surf}$ (m/s) | Flow depth, $h$ (m) | Subsurface velocity, $u_0$ (m/s) | Flow Reynolds number, Re | Froude number, Fr | Relative roughness, $k_s/h$ | Roughness Reynolds number, $\mathrm{Re}_{k_s}$ | Shields number, $\tau_*$ | Subsurface Reynolds Number, $\mathrm{Re}_{sub}$ |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1 | 3.8E-03 | 0.692 | 1.8E-03 | 1.39 | 0.50 | - | 6.9E+05 | 0.63 | 0.32 | 2.2E+04 | 0.023 | 3.1E+03 |
| 2 | 3.8E-03 | 0.69 | 1.8E-03 | 1.32 | 0.52 | - | 6.9E+05 | 0.59 | 0.31 | 2.2E+04 | 0.024 | 3.2E+03 |
| 3 | 3.8E-03 | 0.14 | 8.7E-04 | 0.66 | 0.21 | - | 1.4E+05 | 0.45 | 0.74 | 1.4E+04 | 0.010 | 1.5E+03 |
| 4 | 3.9E-03 | 0.03 | 4.7E-04 | 0.32 | 0.10 | - | 3.1E+04 | 0.32 | 1.63 | 9.8E+03 | 0.005 | 8.3E+02 |
| 5 | 3.9E-03 | 0.03 | 4.8E-04 | 0.31 | 0.10 | - | 3.1E+04 | 0.32 | 1.60 | 9.9E+03 | 0.005 | 8.4E+02 |
| 6 | 3.9E-03 | 0.03 | 4.9E-04 | 0.31 | 0.10 | - | 3.1E+04 | 0.31 | 1.57 | 1.0E+04 | 0.005 | 8.5E+02 |
| 7* | 3.9E-03 | 0.032 | 4.9E-04 | 0.30 | 0.10 | 0.16 | 3.1E+04 | 0.30 | 1.55 | 1.0E+04 | 0.005 | 8.6E+02 |
| 8 | 3.9E-03 | 0.154 | 8.1E-04 | 0.80 | 0.19 | - | 1.5E+05 | 0.58 | 0.83 | 1.4E+04 | 0.009 | 1.4E+03 |
| 9 | 3.9E-03 | 0.154 | 8.8E-04 | 0.72 | 0.21 | - | 1.5E+05 | 0.50 | 0.76 | 1.4E+04 | 0.010 | 1.5E+03 |
| 10* | 3.9E-03 | 0.154 | 9.1E-04 | 0.69 | 0.22 | 0.27 | 1.5E+05 | 0.47 | 0.72 | 1.5E+04 | 0.011 | 1.6E+03 |
| 11 | 3.9E-03 | 0.32 | 1.3E-03 | 0.96 | 0.34 | 0.32 | 3.2E+05 | 0.53 | 0.48 | 1.8E+04 | 0.016 | 2.3E+03 |
| 12 | 3.9E-03 | 0.32 | 1.3E-03 | 0.95 | 0.34 | - | 3.2E+05 | 0.52 | 0.47 | 1.8E+04 | 0.016 | 2.3E+03 |
| 13* | 3.9E-03 | 0.51 | 1.6E-03 | 1.21 | 0.42 | 0.38 | 5.1E+05 | 0.60 | 0.38 | 2.0E+04 | 0.020 | 2.8E+03 |
| 14 | 3.9E-03 | 0.02 | 4.3E-04 | 0.23 | 0.09 | - | 2.0E+04 | 0.25 | 1.85 | 9.2E+03 | 0.004 | 7.5E+02 |

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|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 15 | 3.9E-03 | 0.65 | 1.8E-03 | 1.36 | 0.48 | - | 6.5E+05 | 0.63 | 0.34 | 2.2E+04 | 0.023 | 3.1E+03 |
| 16 | 3.9E-03 | 0.32 | 1.3E-03 | 0.94 | 0.34 | - | 3.2E+05 | 0.52 | 0.48 | 1.8E+04 | 0.016 | 2.3E+03 |
| 17* | 1.9E-02 | 0.50 | 4.5E-03 | 1.84 | 0.27 | 0.82 | 4.9E+05 | 1.14 | 0.60 | 3.6E+04 | 0.064 | 7.9E+03 |
| 18* | 1.9E-02 | 0.30 | 3.6E-03 | 1.50 | 0.20 | 0.74 | 3.0E+05 | 1.08 | 0.81 | 3.1E+04 | 0.047 | 6.3E+03 |
| 19* | 1.9E-02 | 0.160 | 2.8E-03 | 1.09 | 0.14 | 0.60 | 1.6E+05 | 0.92 | 1.12 | 2.6E+04 | 0.034 | 4.9E+03 |
| 20* | 1.9E-02 | 0.031 | 1.8E-03 | 0.39 | 0.07 | 0.33 | 2.9E+04 | 0.47 | 2.18 | 1.9E+04 | 0.018 | 3.1E+03 |
| 21 | 1.9E-02 | 0.01 | 1.0E-03 | 0.24 | 0.03 | - | 6.6E+03 | 0.46 | 5.76 | 1.2E+04 | 0.007 | 1.8E+03 |
| 22 | 1.9E-02 | 0.598 | 4.9E-03 | 1.97 | 0.30 | - | 5.9E+05 | 1.15 | 0.53 | 3.8E+04 | 0.072 | 8.6E+03 |
| 23 | 1.9E-02 | 0.693 | 5.2E-03 | 2.11 | 0.33 | - | 6.9E+05 | 1.18 | 0.49 | 4.0E+04 | 0.078 | 9.1E+03 |
| 24 | 2.0E-02 | 0.31 | 3.6E-03 | 1.51 | 0.20 | - | 3.0E+05 | 1.08 | 0.80 | 3.1E+04 | 0.049 | 6.4E+03 |
| 25 | 2.0E-02 | 0.14 | 2.7E-03 | 1.01 | 0.13 | - | 1.3E+05 | 0.89 | 1.21 | 2.6E+04 | 0.032 | 4.7E+03 |
| 26 | 2.1E-02 | 0.51 | 4.8E-03 | 1.88 | 0.27 | - | 5.0E+05 | 1.16 | 0.60 | 3.8E+04 | 0.071 | 8.5E+03 |
| 27 | 2.1E-02 | 0.15 | 3.0E-03 | 1.06 | 0.14 | - | 1.5E+05 | 0.90 | 1.14 | 2.8E+04 | 0.037 | 5.3E+03 |
| 28 | 2.1E-02 | 0.29 | 3.9E-03 | 1.46 | 0.20 | - | 2.9E+05 | 1.05 | 0.81 | 3.3E+04 | 0.052 | 6.8E+03 |
| 29 | 2.1E-02 | 0.51 | 4.9E-03 | 1.88 | 0.27 | - | 5.0E+05 | 1.16 | 0.60 | 3.8E+04 | 0.071 | 8.5E+03 |
| 30 | 2.1E-02 | 0.15 | 3.0E-03 | 1.07 | 0.14 | - | 1.5E+05 | 0.92 | 1.15 | 2.7E+04 | 0.037 | 5.2E+03 |
| 31 | 2.1E-02 | 0.29 | 3.8E-03 | 1.48 | 0.19 | - | 2.9E+05 | 1.07 | 0.82 | 3.2E+04 | 0.052 | 6.7E+03 |

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|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 32 | 2.2E-02 | 0.15 | 3.0E-03 | 1.09 | 0.14 | - | 1.5E+05 | 0.94 | 1.18 | 2.7E+04 | 0.036 | 5.2E+03 |
| 33 | 2.2E-02 | 0.293 | 3.8E-03 | 1.52 | 0.19 | - | 2.9E+05 | 1.11 | 0.84 | 3.2E+04 | 0.051 | 6.7E+03 |
| 34 | 8.1E-02 | 0.52 | 1.1E-02 | 2.67 | 0.19 | - | 5.1E+05 | 1.96 | 0.85 | 6.2E+04 | 0.189 | 1.9E+04 |
| 35 | 8.1E-02 | 0.52 | 1.1E-02 | 2.67 | 0.19 | - | 5.1E+05 | 1.96 | 0.84 | 6.2E+04 | 0.189 | 1.9E+04 |
| 36 | 8.1E-02 | 0.517 | 1.1E-02 | 2.66 | 0.19 | - | 5.1E+05 | 1.95 | 0.84 | 6.2E+04 | 0.189 | 1.9E+04 |
| 37* | 8.1E-02 | 0.289 | 8.6E-03 | 2.09 | 0.13 | 1.83 | 2.8E+05 | 1.82 | 1.19 | 5.2E+04 | 0.134 | 1.5E+04 |
| 38 | 8.1E-02 | 0.44 | 1.0E-02 | 2.48 | 0.17 | - | 4.3E+05 | 1.91 | 0.93 | 5.9E+04 | 0.172 | 1.8E+04 |
| 39* | 8.1E-02 | 0.39 | 9.6E-03 | 2.39 | 0.16 | 1.80 | 3.8E+05 | 1.90 | 1.00 | 5.7E+04 | 0.159 | 1.7E+04 |
| 40* | 8.1E-02 | 0.15 | 7.0E-03 | 1.51 | 0.10 | 1.68 | 1.5E+05 | 1.55 | 1.66 | 4.4E+04 | 0.096 | 1.2E+04 |
| 41* | 8.1E-02 | 0.03 | 4.9E-03 | 0.48 | 0.05 | 0.57 | 2.5E+04 | 0.68 | 3.12 | 3.2E+04 | 0.051 | 8.6E+03 |
| 42 | 1.5E-01 | 0.011 | 6.2E-03 | 0.15 | 0.03 | - | 4.5E+03 | 0.29 | 5.47 | 3.3E+04 | 0.054 | 1.1E+04 |
| 43 | 1.5E-01 | 0.03 | 7.4E-03 | 0.56 | 0.04 | - | 2.4E+04 | 0.85 | 3.67 | 4.0E+04 | 0.081 | 1.3E+04 |
| 44 | 1.5E-01 | 0.51 | 1.5E-02 | 3.02 | 0.16 | - | 4.9E+05 | 2.38 | 0.98 | 7.8E+04 | 0.302 | 2.6E+04 |
| 45* | 1.5E-01 | 0.16 | 1.1E-02 | 1.76 | 0.09 | 2.04 | 1.5E+05 | 1.89 | 1.82 | 5.7E+04 | 0.162 | 1.8E+04 |
| 46* | 1.5E-01 | 0.492 | 1.5E-02 | 3.08 | 0.15 | 2.26 | 4.8E+05 | 2.50 | 1.03 | 7.6E+04 | 0.286 | 2.5E+04 |
| 47* | 1.5E-01 | 0.303 | 7.7E-03 | 2.87 | 0.11 | 2.26 | 3.3E+05 | 7.80 | 1.40 | 2.6E+04 | 0.162 | 1.3E+04 |
| 48 | 1.6E-01 | 0.01 | 6.2E-03 | 0.15 | 0.03 | - | 4.0E+03 | 0.29 | 6.03 | 3.2E+04 | 0.051 | 1.1E+04 |

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|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 49 | 1.6E-01 | 0.49 | 1.5E-02 | 3.24 | 0.15 | - | 4.8E+05 | 2.69 | 1.09 | 7.6E+04 | 0.285 | 2.6E+04 |
| 50 | 3.0E-01 | 0.02 | 1.0E-02 | 0.34 | 0.03 | - | 9.5E+03 | 0.64 | 5.67 | 4.5E+04 | 0.103 | 1.8E+04 |
| 51 | 3.0E-01 | 0.09 | 1.4E-02 | 1.19 | 0.06 | - | 7.5E+04 | 1.52 | 2.54 | 6.7E+04 | 0.231 | 2.5E+04 |
| 52 | 3.0E-01 | 0.02 | 1.1E-02 | 0.34 | 0.04 | - | 1.2E+04 | 0.56 | 4.34 | 5.1E+04 | 0.135 | 2.0E+04 |
| 53 | 3.0E-01 | 0.49 | 2.0E-02 | 3.66 | 0.13 | - | 4.7E+05 | 3.25 | 1.23 | 9.6E+04 | 0.475 | 3.6E+04 |
| 54 | 3.0E-01 | 0.15 | 1.5E-02 | 1.91 | 0.07 | - | 1.4E+05 | 2.25 | 2.19 | 7.2E+04 | 0.268 | 2.7E+04 |
| 55 | 3.0E-01 | 0.500 | 2.1E-02 | 3.69 | 0.13 | - | 4.8E+05 | 3.26 | 1.23 | 9.6E+04 | 0.476 | 3.6E+04 |
| 56 | 3.0E-01 | 0.02 | 1.0E-02 | 0.45 | 0.03 | - | 1.3E+04 | 0.82 | 5.37 | 4.6E+04 | 0.109 | 1.8E+04 |
| 57 | 3.0E-01 | 0.15 | 1.6E-02 | 1.82 | 0.08 | - | 1.4E+05 | 2.11 | 2.12 | 7.3E+04 | 0.276 | 2.7E+04 |
| 58 | 3.0E-01 | 0.007 | 0.009 | - | 0.017 | - | - | - | 9.26 | 3.5E+04 | 0.063 | 8.7E+03 |

***** Indicates experiments with an ADV profile

† Subsurface discharge was calculated, not measured, using $Q_{sub} = U_{sub}PW$