Proceedings of the Institution of Civil Engineers
Water Management 161
June 2008 Issue WM3
Pages 183–184
doi: 10.1680/wama.2008.161.3.183

Paper 800004

Paper published:
Proc. Instn Civ. Engrs Wtr Mngmnt, 2006, **159**, June, 139–143

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Institution of Civil Engineers

Discussion: Air entrainment and oxygen transfer in high-head gated conduits

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Hydraulic jumps, water falls and stepped channels promote oxygen transfer from air into water. These hydrodynamic processes are, however, also characterised by energy dissipation, strong turbulence and local scouring.[12] In closed conduits, the formation of hydraulic jumps is not desirable as they can cause destructive effects. Fig. 8 (using the data of Liu[13]) shows Reynolds shear stress (τ) variation through a hydraulic jump. The Reynolds shear stress was calculated from

$$\tau = -\rho\overline{u'v'} \quad (6)$$

where ρ is the density of water and u' and v' are the turbulent fluctuation velocities in stream-wise and vertical directions, respectively. Fig. 8 shows the intensive hydrodynamic effect of the hydraulic jump. Accordingly, the authors' recommendation of using closed gates to enhance dissolved oxygen content is questionable.

Secondly, Ozkan *et al.* investigated the hydraulic jump aeration efficiency as a function of upstream flow velocity. This parameter was also used by Holler,[14] who correlated the hydraulic jump aeration efficiency with the second power of the velocity difference. The author argues that using a dimensionless parameter—the upstream Froude number (Fr_1)—would be more meaningful than using the flow velocity. Fr_1 is calculated from

$$Fr_1 = U_1/(\mathrm{g}d_1)^{1/2} \quad (7)$$

where U_1 is the depth-averaged velocity before the hydraulic jump, g is acceleration due to gravity and d_1 is the flow depth before the hydraulic jump (Fig. 9). Studies demonstrate that

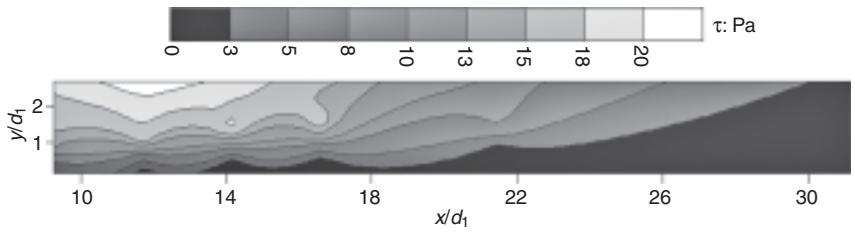

Fig. 8. Reynolds shear stress distribution along a hydraulic jump: $Fr_1 = 3{\cdot}35$, $Re = 86\,100$ (Reynolds number)

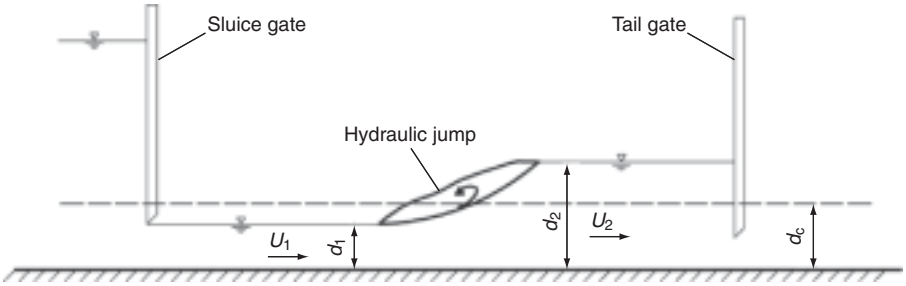

Fig. 9. Schematic representation of a classical hydraulic jump

hydraulic jump flow characteristics are under the control of Fr_1.[15] For example, Avery and Novak[16] correlated the aeration efficiency with a 2·1 power of Fr_1. Consequently, the author recommends using Fr_1 as the main parameter for investigating hydraulic jump aeration performance.

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