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A Model for Polygonal Hydraulic Jumps TOMAS BOHR, Physics Dept. and Center for Fluid Dynamics, Technical University of Denmark, ERIK MARTENS, Theoretical and Applied Mechanics, Cornell University, USA, JOHAN RøNBY PEDERSEN, Math Dept. and Center for Fluid Dynamics, Technical University of Denmark, JESPER LARSEN, IMFUFA, Roskilde University, Denmark, SHINYA WATANABE, Department of Mathematical Sciences, University of Ibaraki, Japan — We present a model for the shape of polygonal hydraulic jumps discovered by Ellegaard et al. 1998 and modeled there by a force balance (an inward push of gravity and an outward pull of viscous stresses) on the "surface roller" in the jump-region, which is known to be a prerequisite for the occurrence of polygonal jumps. We develop this model, replacing their unexplained "line tension" by a more detailed modeling of the flow in the roller, including the tangential flow. We solve a simplified model exactly in which each polygon exists in a finite region of parameter space with shapes very similar to those observed in experiments. The number of corners N in the polygon scale as $N \sim (Q\nu)^2 h_o^{-4} h_i^{-3}$, in terms of the volumetric flux Q, the inner height h_i, the outer height h_o and the viscosity ν. In contrast to recent work by Bush et al. 2006, our model does not include surface tension explicitly, but since it affects the radius of the jump it will also affect h_i. A reduction of the surface tension will reduce h_i and therefore increase N. If the reduction is strong enough, this could restore the circular symmetry.

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