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Partial-depth lock-release and related phenomena: a vorticity-based analysis MOHAMMAD AMIN KHODKAR, Ph.D. student at University of California, Santa Barbara, MOHAMAD NASR-AZADANI, posdoctoral scholar at University of California, Santa Barbara, ECKART MEIBURG, Professor at University of California, Santa Barbara — We present a vorticity-based model for partial-depth Boussinesq lock exchange flows, without empirical closure assumptions. Upon release of the lock fluid, experiments and DNS simulations show that a gravity current front forms, followed by a rarefaction wave. For sufficiently large ratios of lock height to tank height, a left-propagating internal bore will be generated as well. By employing the conservation of mass in each fluid, along with the overall vorticity, we propose a set of ODEs that predicts the velocity distribution within the rarefaction wave, in addition to the velocity and height of the gravity current front. The model furthermore predicts when a bore is produced, and how it influences the dynamics of the flow. The model predictions are compared to DNS results, as well as to theoretical and experimental results of earlier investigations, and good agreement is observed for all flow properties.

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