**Publications of the Institute of Geophysics, Polish Academy of Sciences**
Geophysical Data Bases, Processing and Instrumentation
vol. 453 (E-14), 2025, pp. 99–99
DOI: 10.25171/InstGeoph_PAS_Publs-2025-052
XLII International School of Hydraulics, Radocza, Poland, 20–23 May 2025

# Critical Submergence for Horizontal Intake Structures under Symmetrical Approach Flow Conditions

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Abstract

Air-entraining vortices at intake structures pose significant challenges to the operation of water intake systems, leading to efficiency losses and potential damage to hydraulic equipment. This study focuses on predicting critical submergence depth, $S_c$, the vertical distance required to prevent air-entrainment vortices, for horizontal intakes under symmetrical approach flow conditions. Dimensional analysis is employed, analyzing the effect of intake geometry, Froude number, Reynolds number, and Weber number. 409 experimental data observations were reanalyzed from different studies to derive more general and accurate empirical equations predicting dimensionless critical submergence, $S_c/D_i$. The analysis revealed that the intake Froude number $(Fr)_i$ and the geometric parameter, $2b/D_i$, are the dominant factors influencing $S_c/D_i$. Moreover, it is stated that narrower sidewall clearances are more prone to the formation of air-entraining vortices at $(Fr)_i$ values smaller than 3.5 while wider ones are at $(Fr)_i$ values greater than 3.5. Empirical equations derived exhibit strong statistical performance, with $R^2$ values up to 0.988. The most accurate empirical equations are obtained while considering all the flow and geometric parameters to predict $S_c/D_i$. On the contrary, the accuracy of the empirical equations considering only $(Fr)_i$ gives moderate results in predicting $S_c/D_i$.