INDIAN INSTITUTE OF TECHNOLOGY GUWAHATI
SHORT ABSTRACT OF THESIS

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Thesis Title: **Hydro-morphological behaviour around erosion protective structure with downward seepage**

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SHORT ABSTRACT

River bank protection is crucial in hydraulic river engineering to safeguard natural rivers, lands, and critical structures like bridges. Spur dikes, aimed at diverting flow from the bank and decreasing velocity, are effective in preventing erosion. Achieving stable river banks and sustainable foundations necessitates an in-depth understanding of scour processes, precise scour depth assessment, and meticulous planning for spur dike installation. This study aimed to optimize spur dike shapes (T-shape, L-shape, and rectangular) for managing flow turbulence and reducing local scour, considering the effect of downward seepage. Results showed that T-shaped dikes had the lowest scour depths, both with and without seepage. Without seepage, L-shaped dikes had the greatest scour depth, but with seepage, rectangular dikes had the deepest scour. Maximum velocity was observed near the water surface around rectangular dikes, and this increased with seepage. T-shaped dikes, in contrast, exhibited weaker velocities. The negative impact on velocity and RSS magnitude was observed at the near channels bed at maximum scour depth and was linked to flow reversal, horseshoe vortices, and particle detachment, which was accelerated by downward seepage, deepening scour depressions.

The current work also uses an experimental method to analyse a multiscale statistical assessment of scour depth surrounding the T-shape spur dikes with downward seepage. Results indicated that the celerity of scour depth for both time and length scales depends on the downward seepage. Initially, the scour develops at a higher rate, but over time, this rate decreases until it becomes constant.

The study also examined the effects of different combinations of permeable and impermeable T-shaped spur dikes (Sets A, B, and C) on bed morphology and scour progression under downward seepage. Set-A (0%, 0%, 0%) consisted of three impermeable spur dikes (where 0% permeability provided) arranged in series, while Set-B (60%, 0%, 0%) included a 60% permeable first spur dike with the other two remaining impermeable. In Set-C (60%, 30%, 0%), Spur-1 was 60% permeable, Spur-2 was 30% permeable, and Spur-3 remained impermeable. Results showed that permeable Sets B and C significantly reduced maximum scour depth at the initial spur dike without seepage by 37.6% and 55.2%, respectively, compared to impermeable Set-A. This reduction trend continued under seepage conditions, *V*S1 and *V*S2. Set-B reduced scour depth by 38.5% (*V*S1) and 35.3% (*V*S2), while Set-C achieved reductions of 42.4% (*V*S1) and 47.4% (*V*S2). Set-C was the most effective at reducing scour, while Set-A produced the deepest scour. Downward seepage increased sediment particle movement, leading to deeper scour formations beginning at the spur dike tip.

The experimental study also investigates how different orientations of spur dikes (60°, 90°, and 120°) affect bed morphology and scour development over time. It compares maximum scour depths with and without downward seepage. Results indicate that a 90° orientation produces the deepest scour, while 120° results in the least. Downward seepage exacerbates sediment motion, leading to increased particle detachment and deeper scour depressions.