EFFECT OF SAND MINING ON SCOURING AROUND BRIDGE PIERS IN SRI LANKA – CASE STUDY OF KELANISIRI BRIDGE

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The scouring around bridge piers by flowing water, known as bridge scour, is one of the most significant contributors to bridge instability and collapse. This issue is intensified in Sri Lanka due to the hydrological characteristics of the river environment, with uncontrolled sand mining in rivers, leading to excess sediment imbalance and lowering of the riverbed levels, posing a greater risk to bridge abutments.

This study investigates the effects of sand mining on scour development around bridge piers, focusing on the Kelanisiri Bridge, located over the Kelani River, Sri Lanka's second-largest river basin. The Kelani River, with its seasonal floods and active sediment transport, combined with intensive sand mining, presents a complex environment where scour risks are heightened. The research employed controlled laboratory experiments using a scaled physical model of the bridge and river system to simulate and monitor scour processes under both natural conditions and mining-affected scenarios. The experiments allowed for detailed observation of scour patterns, mechanisms, and maximum scour depths around the piers. Special emphasis was placed on understanding how the location and levels of sand mining upstream affect the development and progression of local scour. In addition to the physical modelling, numerical simulations were carried out using HEC-RAS software to provide comparative data. The results from the numerical modelling were validated against the laboratory findings to assess their reliability. Statistical analysis using R^2 and RMSE was performed to quantify the agreement between physical and numerical results. The findings demonstrate that sand mining substantially increases local scour by intensifying flow turbulence, horseshoe vortex formation, and bed shear stress near bridge piers.

Under conditions of mining influence, the depths of scour holes tended to be larger than for natural flows. Through in-depth investigations of scour forms and scour mechanisms, it is concluded that sand mining changes the hydraulic characteristics, which lead to the acceleration of scour. This study indicates the need to introduce maintenance and monitoring plans so that the effects of human activities, such as sand mining, on scour susceptibility can be more effectively assessed. Finally, the investigation contributes to the fundamental knowledge of local scour processes found in tropical river settings, as well as aiding engineers and decision makers involved in improving the stability and safety of bridge structures in rivers affected by sand mining.

Keywords: Bridge scour, Sand mining, Sediment transport, Physical modelling, HEC-RAS simulation

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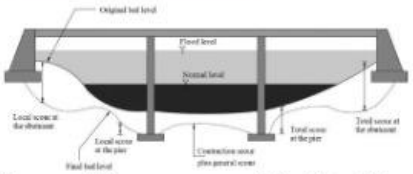
GRAPHICAL ABSTRACT

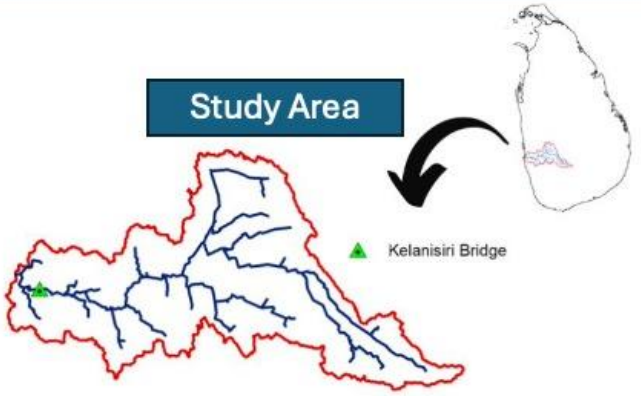
Effect of Sand Mining on Scouring Around Bridge Piers in Sri Lanka - Case Study of Kelanisiri Bridge

Background

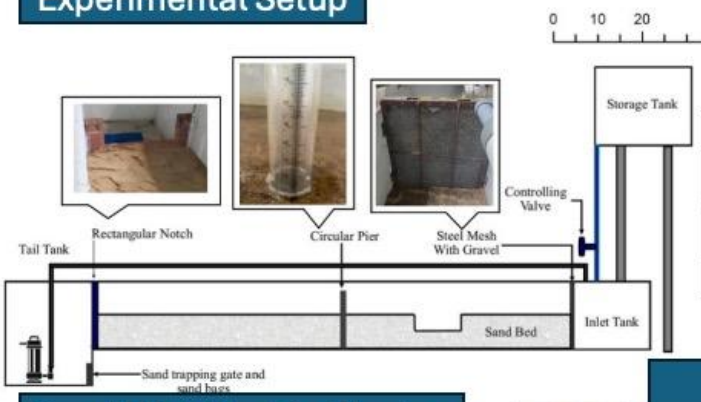


Types of Scour around Bridge Piers

Study Area



Experimental Setup

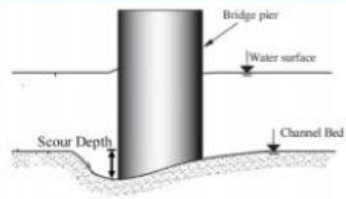


Scale Factors

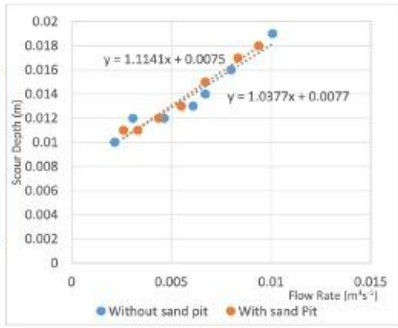
Parameter	Prototype Dimension	Model Dimension	Scale Ratio
Length along the Kelani River	1000 m	1 m	1:1000 (horizontal)
Width of Kelani River near the bridge	81 m	0.9 m	1:90 (horizontal)
Average height of bridge piers	13.5 m	0.85 m	1:16 (vertical)

Sand Pit & Pier Positioning

Scour Development



Results



Comparison with Numerical Model

Prototype Flow Rates (m^3s^{-1})	Scour Depth of Prototype (m)	Scour Depth of HEC-RAS Model (m)
12.395	0.160	0.140
17.670	0.192	0.178
26.669	0.192	0.214
35.057	0.208	0.233