



INDIAN INSTITUTE OF TECHNOLOGY GUWAHATI
SHORT ABSTRACT OF THESIS

Name of the Student : **Sukhjeet Arora**

Roll Number : **206104020**

Programme of Study : **Ph.D.**

Thesis Title: **Turbulence Structure and Bank Erosion Processes in Dredged Channels**

Name of Thesis Supervisor(s) : **Prof. Bimlesh Kumar**

Thesis Submitted to the Department/ Center : **Department of Civil Engineering**

Date of completion of Thesis Viva-Voce Exam : **06/01/2025**

Key words for description of Thesis Work : **Riverbank Erosion, Reynolds Shear Stress, Turbulent Kinetic Energy, Sediment Mining**

SHORT ABSTRACT

Riverbank erosion represents a critical challenge, profoundly influencing geomorphological dynamics and compromising the stability of human and infrastructural systems. The geomorphological impacts include form changes such as lateral channel migration, meanders, and channel expansion. The anthropogenic effects include the threat to floodplain human habitation, agricultural land, and stability of instream hydraulic structures and buried pipelines. Channel dredging for the extraction of sand and gravel has seen a multi-fold rise in the last few decades. Pit excavation directly impacts the fluvial erosion characteristics of the riverbank. Pit action increases the Reynolds shear stress in the near-bank flow, which causes progressive fluvial erosion of the berm at the bank toe. The erosivity of the main channel flow in the riverbank also leads to channel degradation, which increases the exposed height of the bank slope. Pit dredging leads to the generation of stronger ejection bursts which provide a mechanism for berm sediment mobility and erosion. The study reveals that instream mining has notable effects on the inherent nature of higher-order turbulence statistics, especially near the bank slope and toe, as well as the multiscale morphological structures.

Wholly vegetated sections showed highly fluctuating transverse flux, suggesting greater intermixing rather than unidirectional flow. It is recommended to use wholly vegetated covers for riverbanks or near structures affected by lateral flow. This study examines the effects of sparsely dense, flexible vegetation in mitigating the impact of a mining pit. The presence of the pit increased near-bed turbulence and sediment transport, with increased streamwise and transverse Reynolds shear stresses indicating heightened sediment movement. Initially, riverbank erosion was significant, but vegetation helped maintain the bank's profile, contrasting with the erosion observed in unvegetated sections.

Abrupt changes in Reynolds Shear Stress (RSS) at the berm location led to instability and erosion. The combination of vegetation and the sandpit raised turbulent kinetic energy (TKE) near the bed and berm. Analysis revealed significant erosion in unvegetated riverbanks, while the rigid vegetation reduced riverbank erosion. However, main channel erosion increased, with a 67% reduction in bed thickness in no-pit cases and a 7.66% increase in erosion at

the main channel center due to the upstream pit. This study investigates the effectiveness of nature-based solutions in addressing riverbank erosion. It underscores that these solutions, when coupled with the detrimental effects of sediment mining, can significantly undermine riverbed stability. The findings play a crucial role in shaping regulations for sediment mining and in designing effective nature-based solutions to strengthen riverbank stability.

