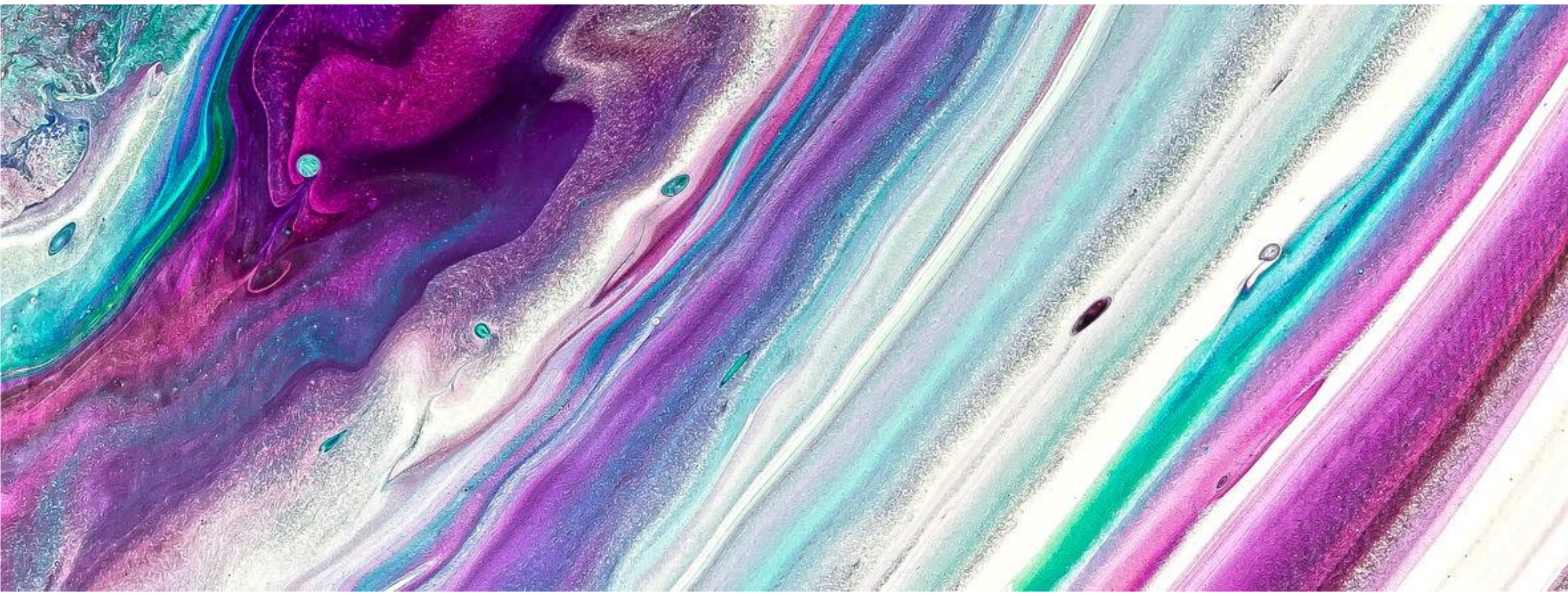
UNIVERSITÀ DEGLI STUDI FIRENZE

DICEA DIPARTIMENTO DI INGEGNERIA CIVILE E AMBIENTALE

INDICEE
International Doctorate in
Civil and Environmental Engineering



Workshops by Subhasish Dey

Indian Institute of Technology Jodhpur

18 July 2024 – h 09.30-11.00 – Room 051

Hydrodynamics of sediment transport: Grain scale to continuum scale

19 July 2024 – h 10.30-12.00 – Room 055

Universal law of pier scour: an application of turbulence phenomenology

Scuola di Ingegneria, Via S. Marta 3 - Firenze

Subhasish Dey

Dept. of Civil and Infrastructure Engineering
Indian Institute of Technology Jodhpur, Rajasthan, India
email: subhasish@iitj.ac.in

Prof. Subhasish Dey is a hydraulician and educator. He is currently a Distinguished Professor and Head of the Department of Civil and Infrastructure Engineering, Indian Institute of Technology (IIT) Jodhpur (2023–). Before, he worked as a Professor of the Department of Civil Engineering, Indian Institute of Technology (IIT) Kharagpur (1998–2023), where he served as the Head of the Department of Civil Engineering during 2013–15. He also held the position of Distinguished Visiting Professor of Tsinghua University, Tsinghua University, Beijing, China (2016–18), Adjunct Professor of Indian Statistical Institute Kolkata (2014–19) and Brahmaputra Chair Professor, IIT Kharagpur during 2009–14 and 2015.

Summary

July 18, 2024

Hydrodynamics of sediment transport: Grain scale to continuum scale

A mechanistic-cum-stochastic theory describing the sediment transport phenomenon from the grain scale of entrainment to the continuum scale of bedload flux under a steady unidirectional flow over a compact sediment bed is developed. The sediment grains, considered as discrete spherical grains, are subjected to hydraulically smooth, transitional, and rough wall-shear flows. At the grain scale, the hydrodynamic forces acting on a sediment grain resting over three closely packed bed grains are analyzed. The criteria for entrainment threshold in rolling, sliding, and lifting modes are determined introducing the velocity fluctuations. Comparison of the computed threshold curves with the experimental data reveals that the entrainment threshold primarily belongs to the transition of the sliding to the lifting modes. Then, at the grain scale, the entrainment probabilities in rolling, sliding, and lifting modes for a given median size of sediment grains are obtained. The rolling and sliding probabilities increase with an increase in Shields parameter and after attaining their individual peak values, they decrease, while the lifting probability increases. Finally, the bedload flux, in a continuum scale, is obtained using the lifting probability.

July 19, 2024

Universal law of pier scour: an application of turbulence phenomenology

A plethora of studies, in the last six decades, have been carried out to formulate the equilibrium scour depth at piers. Despite several attempts, the researchers remain far to achieve a unique relation for the same, because the existing relations traditionally rely on the empiricism. This keynote presents a breakthrough—the universal scaling law of equilibrium scour depth at a circular pier embedded in a sediment bed (in clear-water scour condition) stemming from the turbulence phenomenological theory. The result reveals that the equilibrium scour depth to pier diameter ratio obeys the two-fifths scaling law with the newly coined pier-scour number, that accounts for all possible parameters participating in a local scour phenomenon, namely approach mean flow velocity, threshold shear velocity for sediment grain motion, approach flow depth, pier diameter, and sediment grain size. Importantly, the scaling law contains an additional term in the form of a product of the drag coefficient raised to the power 2/5. The additional term takes account of the pier shape effect on the equilibrium scour depth. The derived unique scaling law preserves the dimensional homogeneity and corroborates with the laboratory experimental measurements.