



Finding the Bed Shear Stress Using the Logarithmic Law at Channel Roughness Transitions

CTIPS-066 – UTC Project Information

Recipient/Grant Number:	North Dakota State University, South Dakota State University Grant No. 69A3552348308
Center Name:	Center for Transformative Infrastructure Preservation and Sustainability
Research Priority:	Preserving the Existing Transportation System
Principal Investigator(s):	Francis Ting, Ph.D., P.E.
Project Partners:	USDOT, Office of the Assistant Secretary for Research and Technology – \$59,996 South Dakota State University – \$63,586
Total Project Cost:	\$123,582
Project Start and End Date:	12/16/2025 to 12/15/2027

Project Description

Flow through transition of bed roughness occurs in many situations in highway transportation including culverts, bridge abutments, and roadways in the floodplain, where the bed materials can change abruptly from one type to another. A sudden change in bed roughness also occurs frequently in the laboratory when soil erosion and scour is studied using a sediment recess in an open-channel flume. In all the above, the bed shear stress is a fundamental flow parameter that must be determined accurately.

A research project is proposed to investigate the use of logarithmic law (log law) for finding bed shear stress near a sudden change in bed roughness. Velocity field measurements will be obtained using a Particle Image Velocimetry (PIV) system. The measured data will be used to determine the distribution of bed shear stress by control volume analysis using the linear momentum equation to determine whether the log law can be applied to a developing boundary layer downstream of a bed roughness transition and develop procedures to reduce the measurement uncertainty of the method.

USDOT Priorities

Section left blank until USDOT's new priorities and RD&T strategic goals are available in Spring 2026.

Outputs

The findings from this project will be published in a peer-reviewed journal paper, in addition to the final project report. Other outputs may include new methods and software (e.g., MATLAB scripts) for finding bed shear stress using the logarithmic law and momentum equation. The project data and software developed will be archived and deposited in SDSU's institutional data repository Open Prairie (<http://openprairie.sdstate.edu>) following the data management plan for CTIPS posted online ([view data management plan](#)). Funding is also allocated for the student to present her work at a regional or national conference.

Outcomes/Impacts

Flow through transition of bed roughness occurs in many situations in highway transportation including culverts, bridge abutments, and roadways through the floodplain. The expected impact of this project will be improved engineering design of highway structures and more cost-effective and efficient placement of scour countermeasures. Sudden changes in bed roughness also occur frequently in the laboratory when soil erosion and scour are studied using a sediment recess in an open-channel flume. Improved understanding of the distribution of bed shear stress in different experimental layouts would allow correct interpretation of measured data. Tangible products in addition to the final report and a journal paper may include new design guidance and recommendations on predicting the distribution of bed shear stress around channel transitions.

The broader impact of this project would be an improved method to determine the bed shear stress on a rough bed using the logarithmic law. The current method is widely criticized for its subjectivity, which may lead to high uncertainties in the measured bed shear stress. The proposed project would shed light on the applicability of the logarithmic law in non-equilibrium boundary layer flows and propose ways to reduce measurement uncertainties using the method.

Final Report

Upon completion, the final report link will be added to the [project page on the CTIPS website](#).