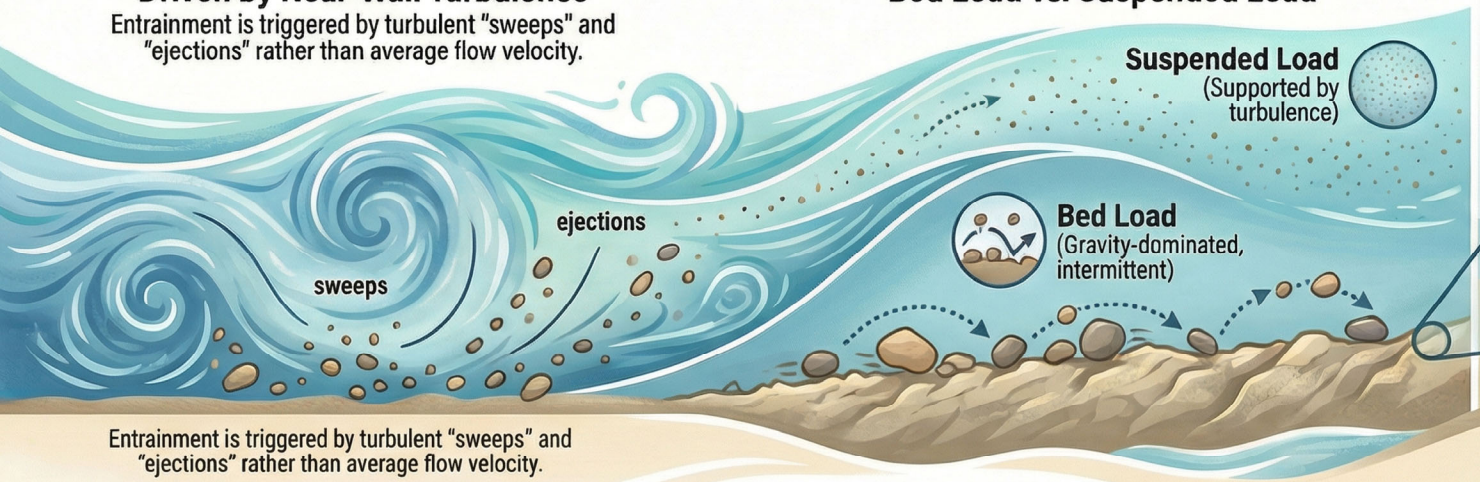
The Mechanics of Bed Load: Physics and Modeling

Physical Foundations of Motion

Driven by Near-Wall Turbulence

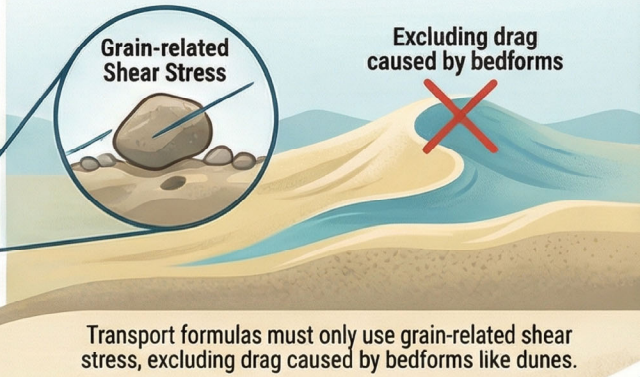
Entrainment is triggered by turbulent "sweeps" and "ejections" rather than average flow velocity.

Bed Load vs. Suspended Load



The Grain Shear Requirement

Transport formulas must only use grain-related shear stress, excluding drag caused by bedforms like dunes.



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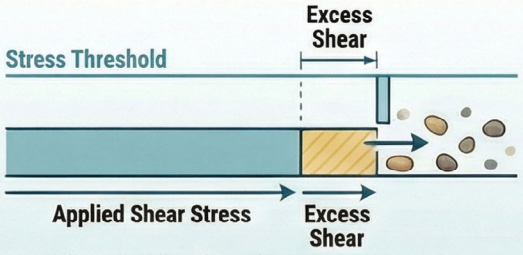
Modeling Transport Rates

Deterministic Excess Shear (MPM)

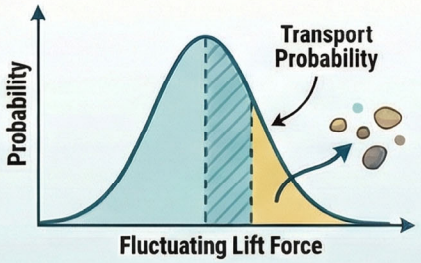


Meyer-Peter & Müller formula assumes transport occurs only after exceeding a sharp stress threshold.

Comparing Dominant Engineering Approaches

	Deterministic (Excess Shear)	Probabilistic (Einstein)
Model Feature	**Threshold Type:** Sharp/Absolute	**Threshold Type:** Gradual/Statistical
	Primary Variable: Excess Shear Stress	**Primary Variable:** Fluctuating Lift Force
	Practical Use: Standard Engineering Tool	**Practical Use:** Theoretical Research

Einstein's Probabilistic Theory



Models motion as a statistical probability based on random fluctuations in turbulent lift forces.

The 1.5 Power Law

Most bed load rates scale with excess shear stress raised to the 3/2 power.