

Absolute size has two effects on transport:

- (i) Grain mass increases faster than area, bigger grains harder to move
- (ii) Viscous effects dampen fluctuations, tiny grains harder to move

Relative size has two effects on transport:

- (i) Little grains “hidden”, harder to move
- (ii) Bigger grains “exposed”, easier to move

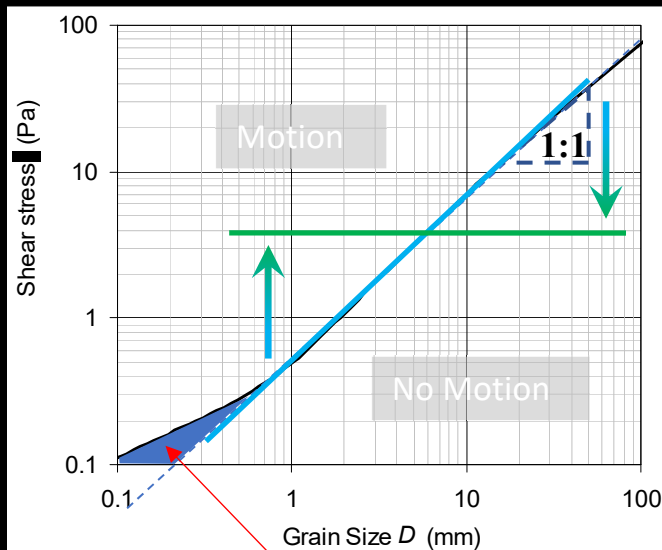
$$\tau_c \propto D$$

$$\tau_c^* = \frac{\tau_c}{(s-1)\rho g D} = const$$

$$\tau_c \propto const$$

$$\tau_c^* = \frac{\tau_c}{(s-1)\rho g D} \propto \frac{1}{D}$$

What if the absolute and relative size effects exactly cancel?



Viscous effects

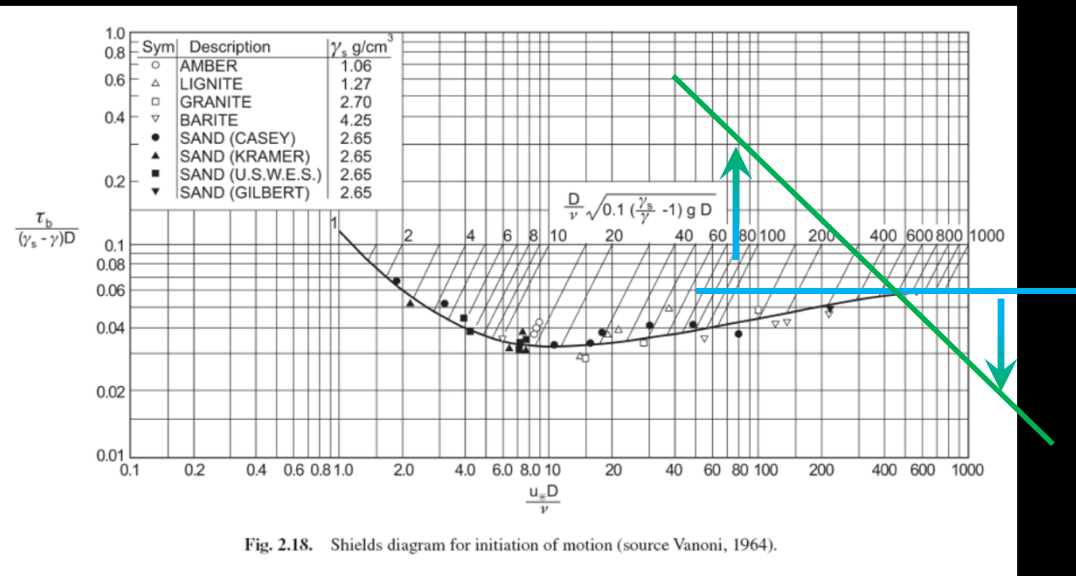
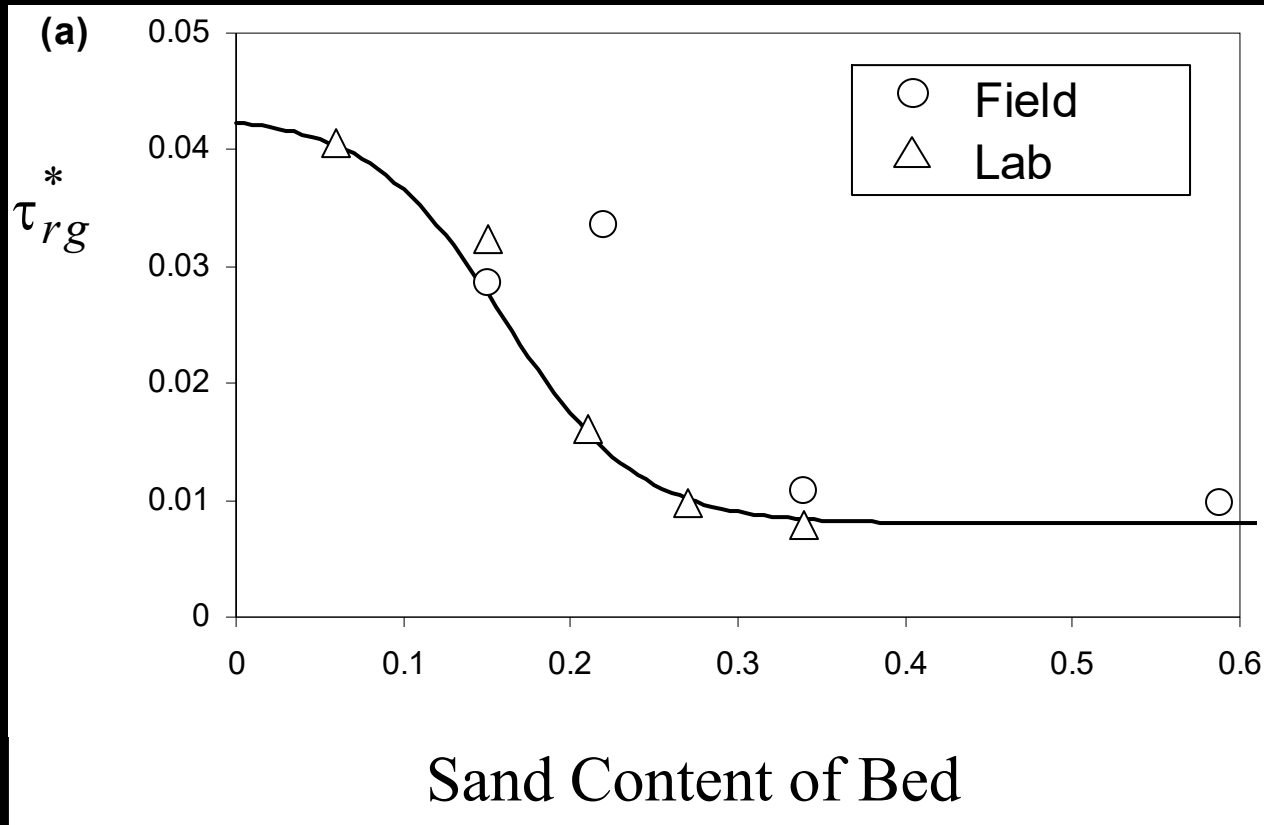


Fig. 2.18. Shields diagram for initiation of motion (source Vanoni, 1964).

Framework
Supported

Matrix
Supported



Increasing fines content of bed surface reduces critical stress of gravel by a factor of *four*

This changes our approach to predicting sediment transport rates:

A fundamental parameter depends on bed grain size

(also found in the many-fraction surface-based model)

$$\tau_{rg}^* = \frac{\tau_{rg}}{(s-1)\rho g D}$$

Wilcock, P.R. and Kenworthy, S.T., 2002, A two fraction model for the transport of sand/gravel mixtures, Water Resources Research, 38(10).

Wilcock, P.R., Kenworthy, S.T. and Crowe, J.C., 2001. Experimental study of the transport of mixed sand and gravel, Water Resources Research

Wilcock, P.R., 1998. Two-fraction model of initial sediment motion in gravel-bed rivers, Science 280:410-412

The first transport problem: incipient motion

The transport model is a defined value of critical Shields Number

For a gravel-bed river, a reasonable choice of D is the median size of the gravel portion of the bed (the framework), measured with a pebble count. For clean, loose gravel,

$$\tau_c^* = \frac{\tau_c}{(s-1)\rho g D} \cong 0.03$$

For a gravel bed that has not been entrained for some time, the grains can become weakly cemented, and they can also become arranged into subtle structures that increase their resistance to movement. This can more than double τ_c^* .



