Prediction of Headcut Erosion Development on the Breach Slope

ICSE-6, 2012, Paris, France

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September 28, 2012

Section of Hydraulic Engineering

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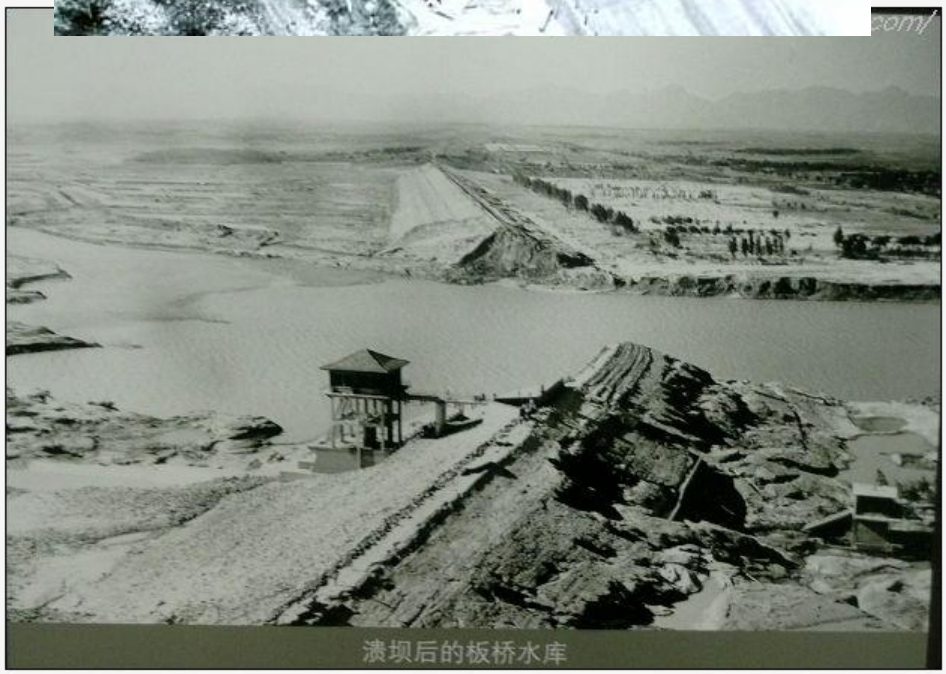
Background



Teton Dam Breach, USA, June 5,1976

Banqiao Breach, China, August, 1975

Background

Lillo-Fort, Belgium, 2012

September 28, 2012

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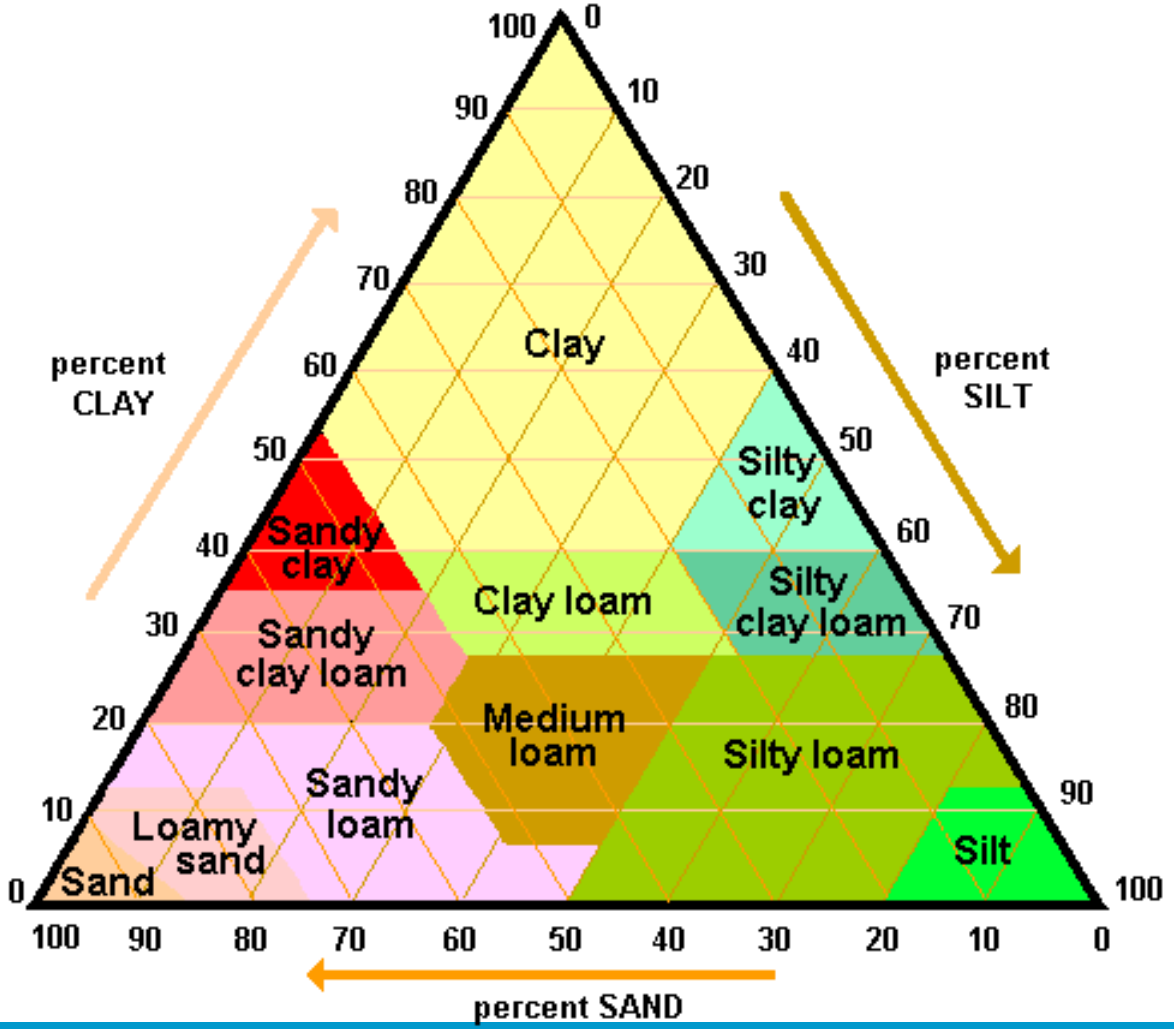
Characteristics of clay



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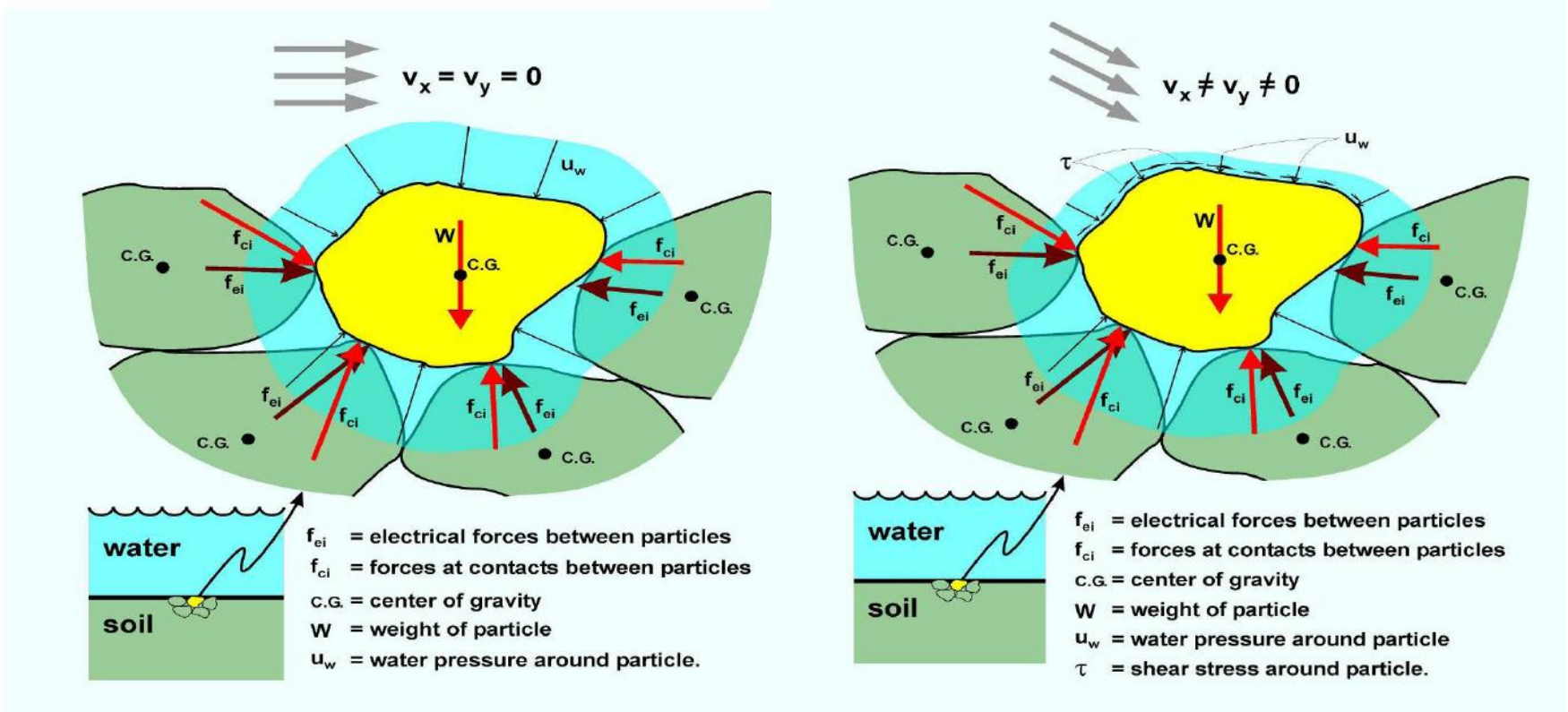
Characteristics of clay



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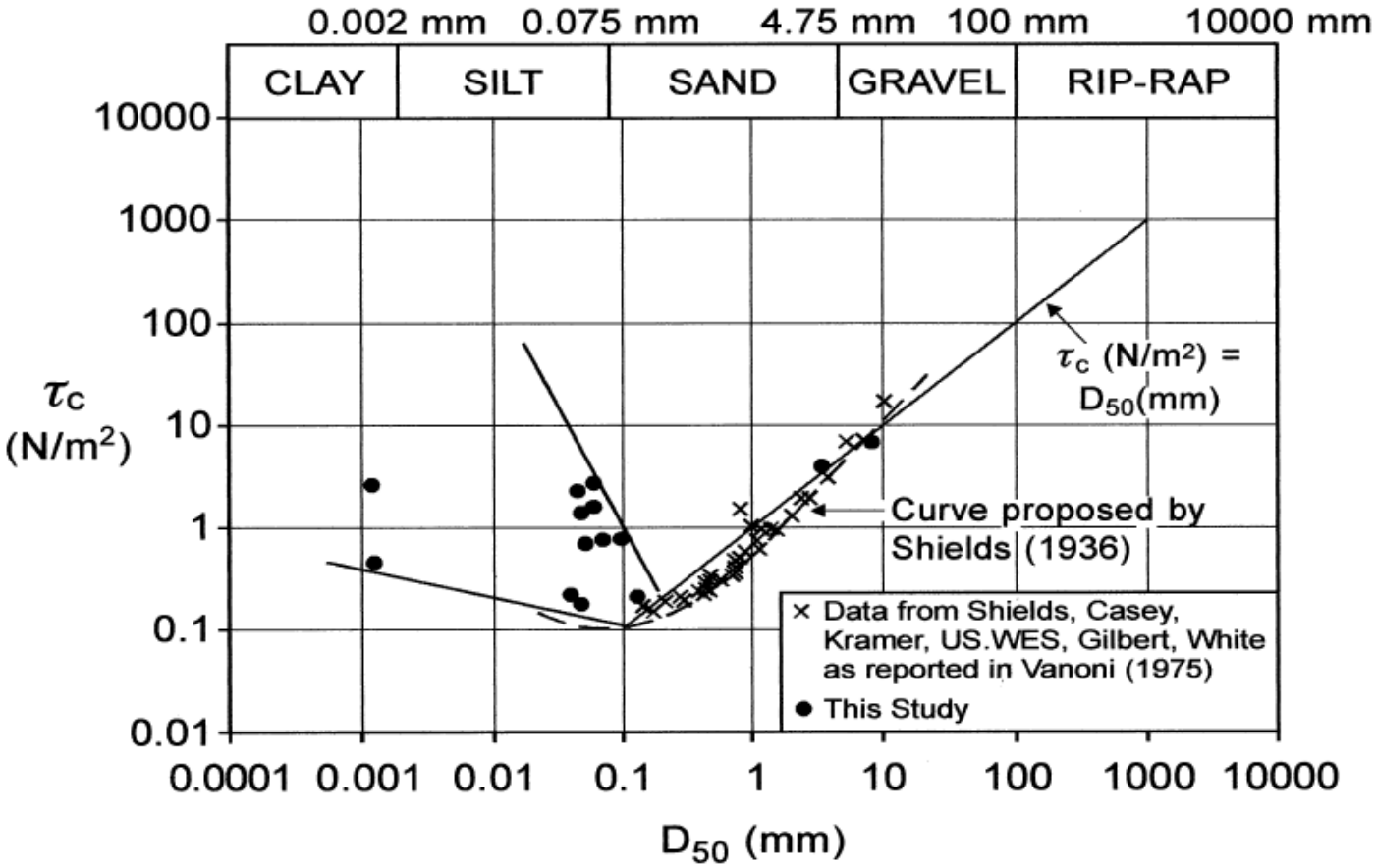
Characteristics of clay



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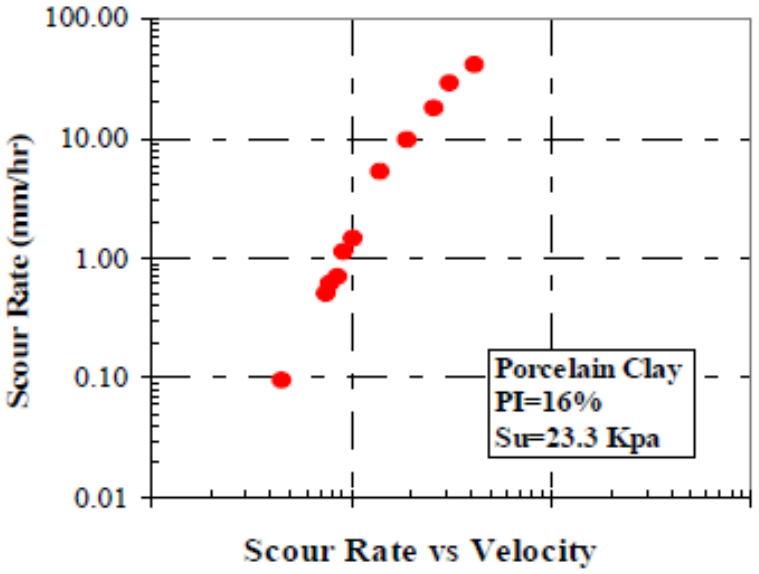
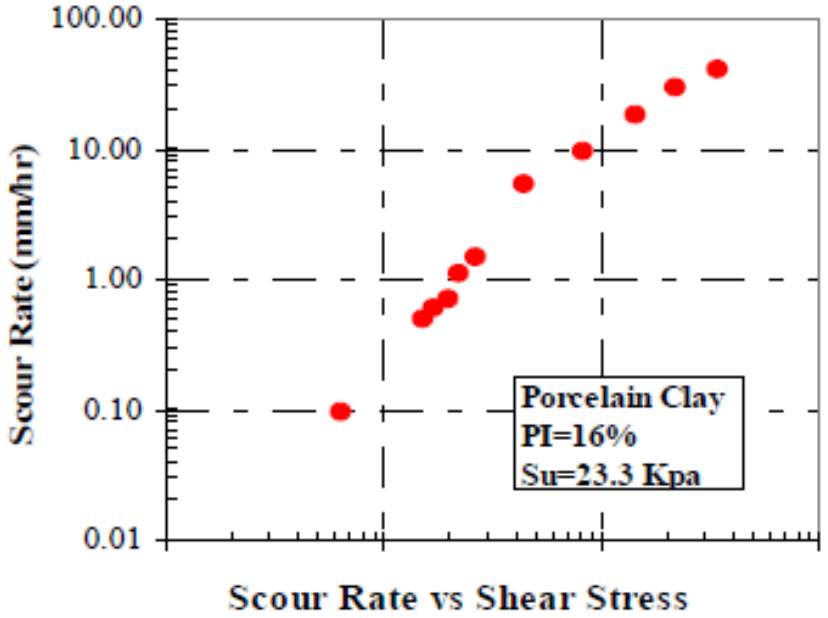
Characteristics of clay





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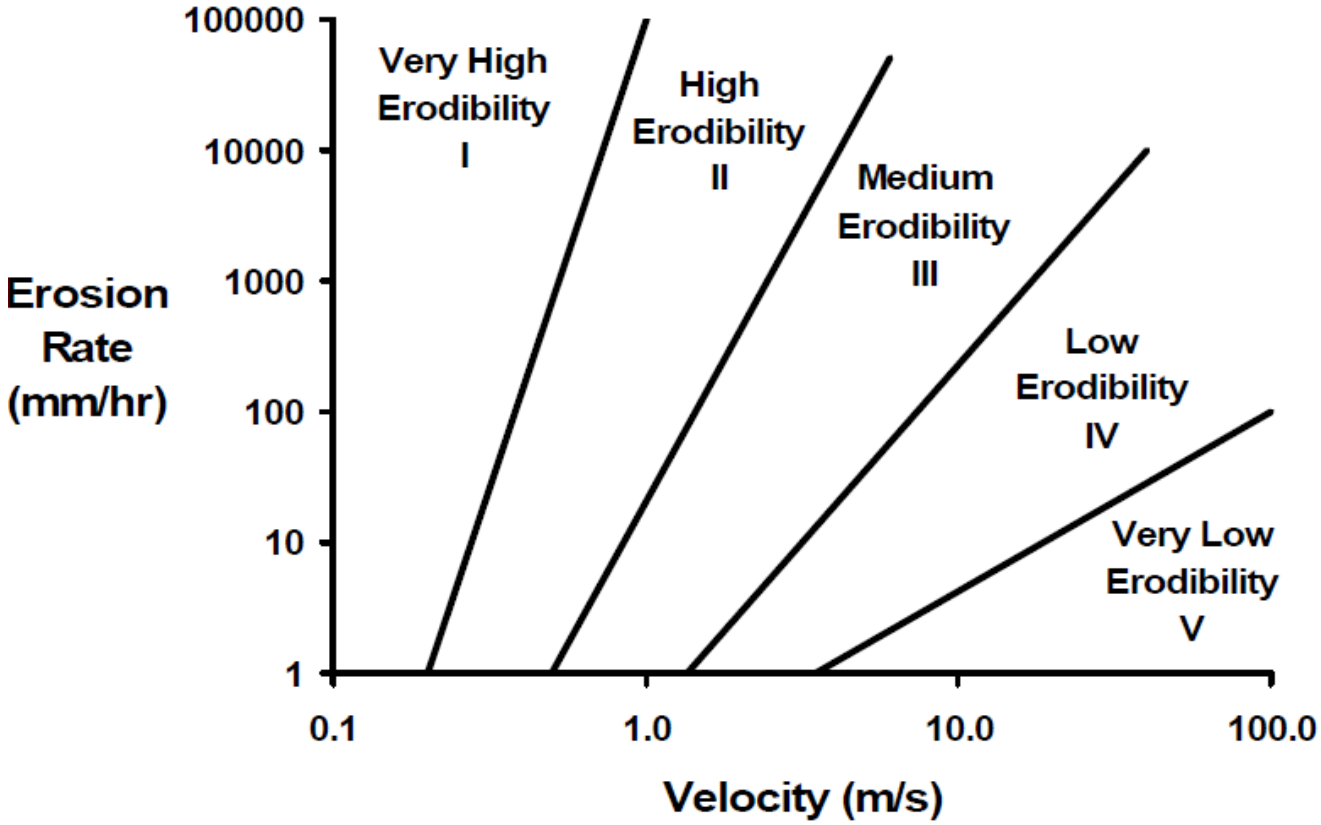
Characteristics of clay



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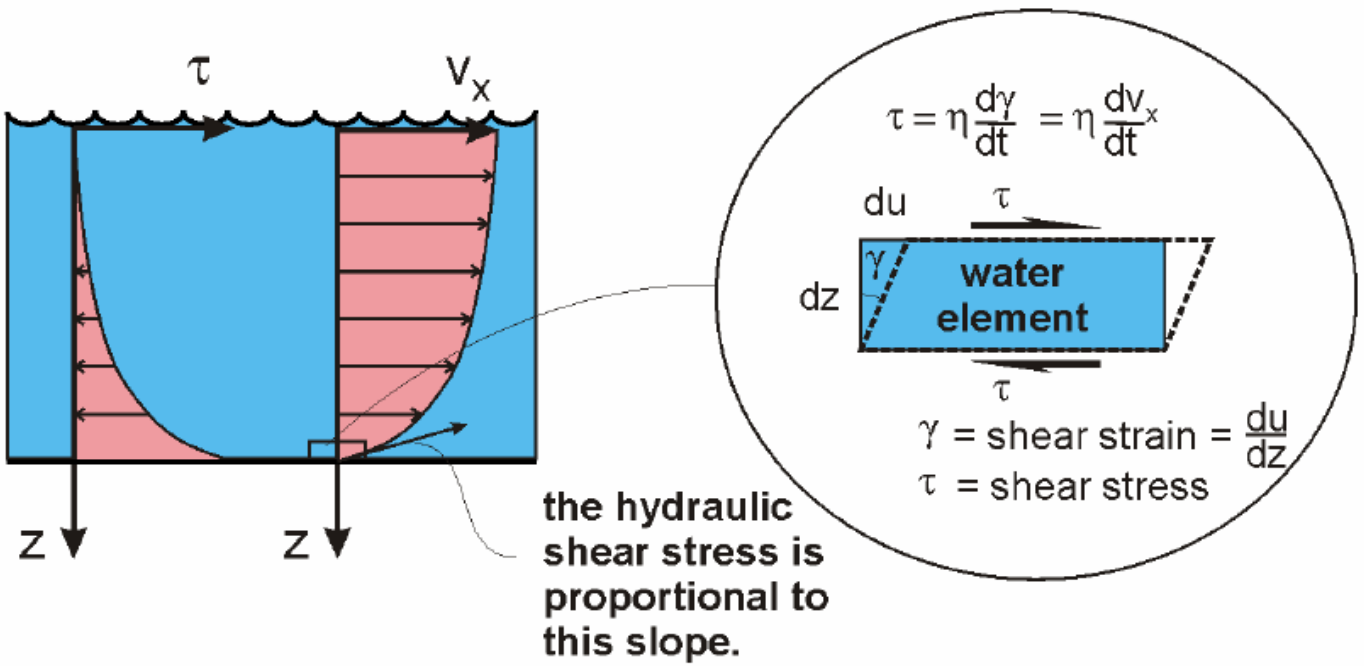
Hydrodynamic Erosion Model



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Hydrodynamic Erosion Model

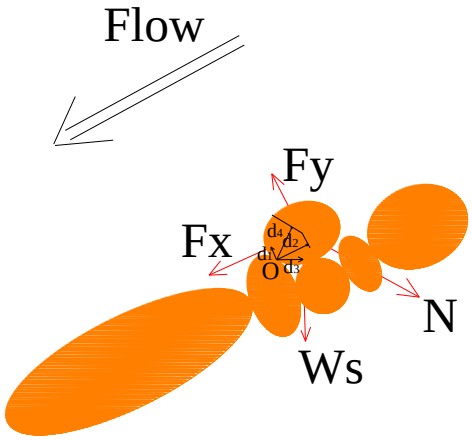
Weight under water

$$W_s = a_1 \frac{\pi}{6}(\gamma_s - \gamma)D^3$$

Shear stress among particles

$$\tau_f = \sigma \tan\varphi + c$$

$$N = \frac{\pi D^2}{4}\tau_f$$



Uplift force

$$F_y = a_2 c_y \frac{\pi D^2}{4}\frac{\rho U_d^2}{2}$$

Drag force

$$F_x = a_3 c_x \frac{\pi D^2}{4}\frac{\rho U_d^2}{2}$$

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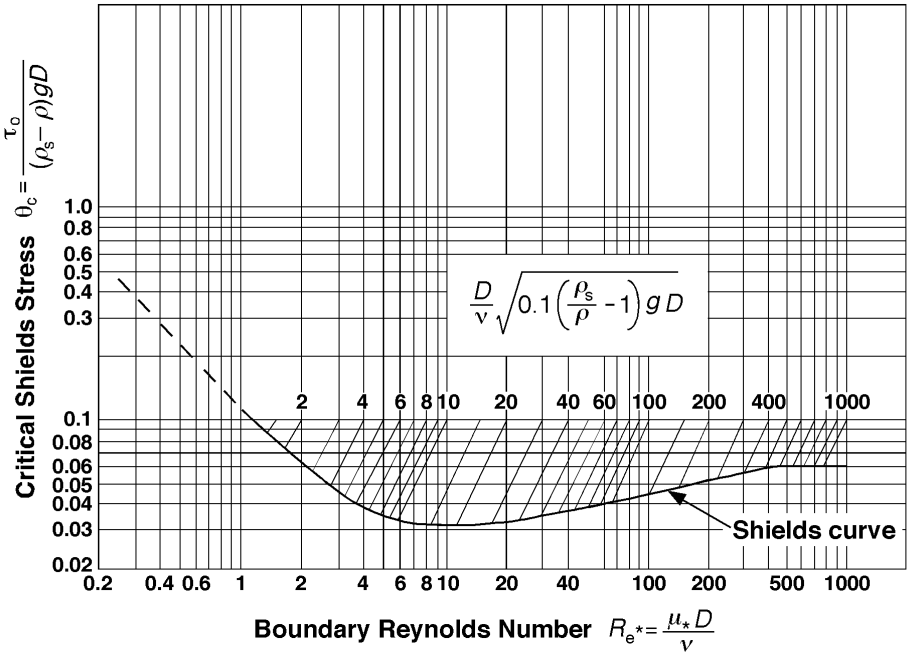
Hydrodynamic Erosion Model

According to Moment equilibrium

$$\frac{\tau_c}{(\gamma_s - \gamma)D} = C\frac{\tau_f}{\rho v^2}\theta_c$$

and /or

$$\tau_c = C'\frac{\tau_0}{\rho v^2}\tau_f$$



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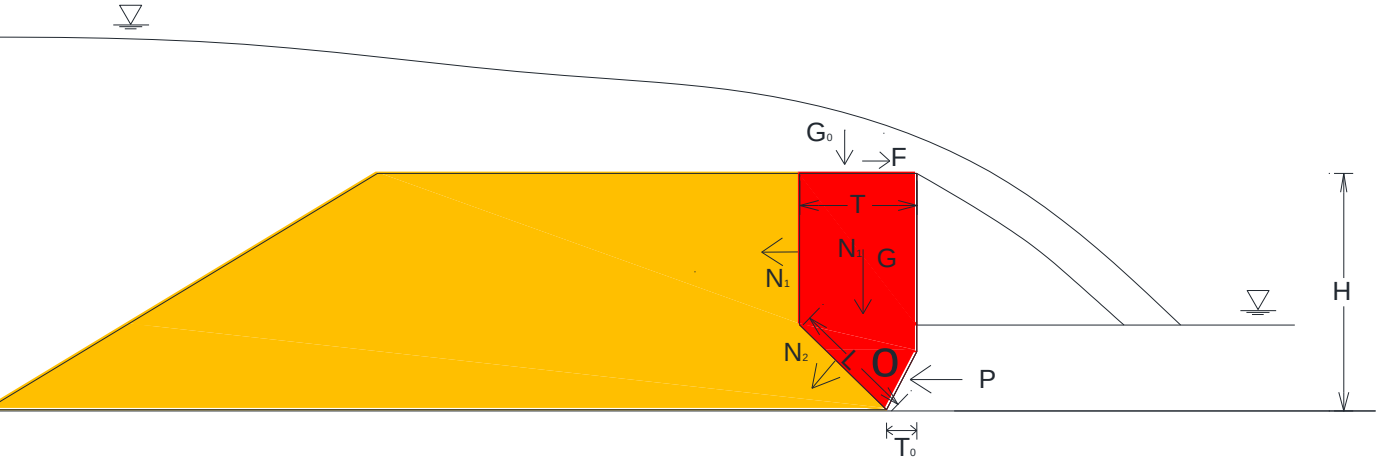
Migration rate



$$\varepsilon = k(\tau_e - \tau_c)^m$$

$$T_0 = f(T)$$

$$\frac{dx}{dt} = \frac{T}{t}$$

$$t = \frac{T_0}{\varepsilon}$$

$$\frac{dx}{dt} = \frac{T}{f(T)}\varepsilon$$

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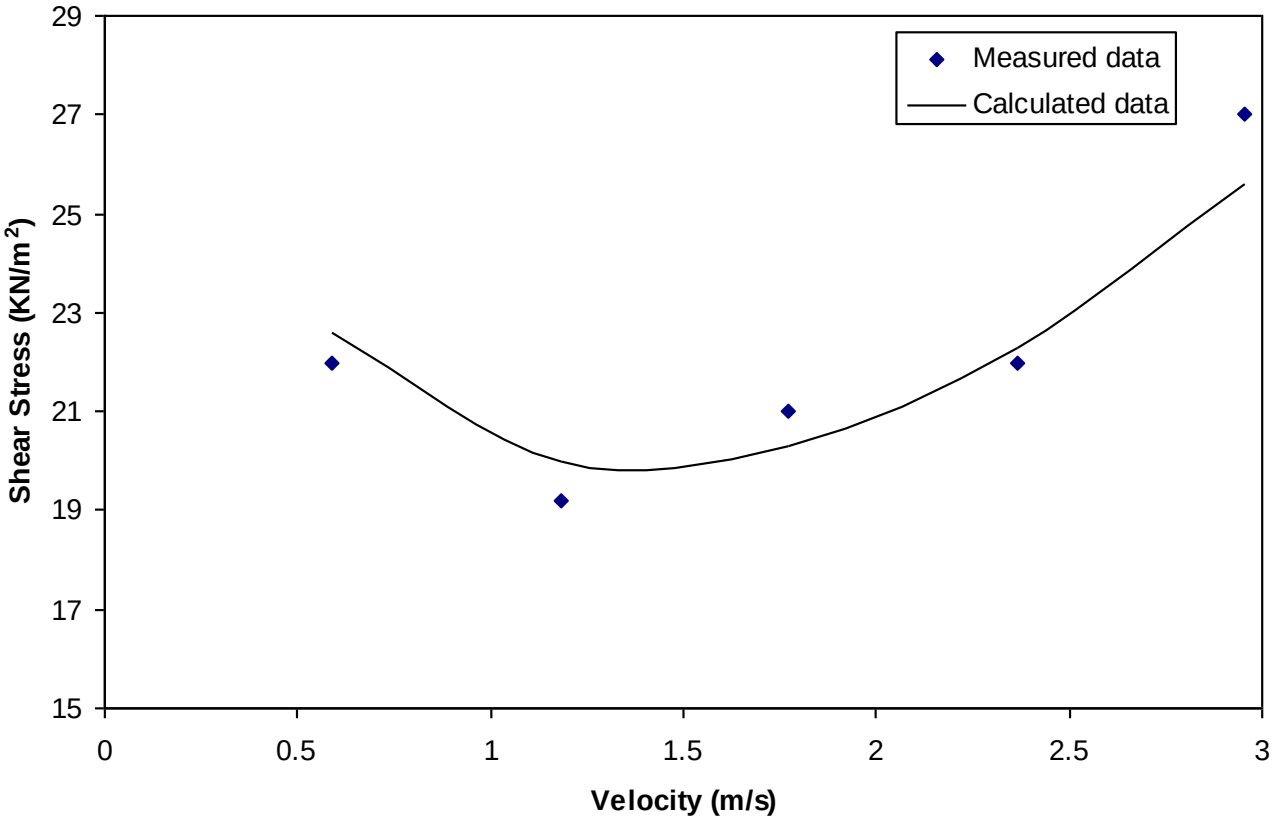
Analysis and discussion



Comparison of shear stress between measured data and calculated data for EG

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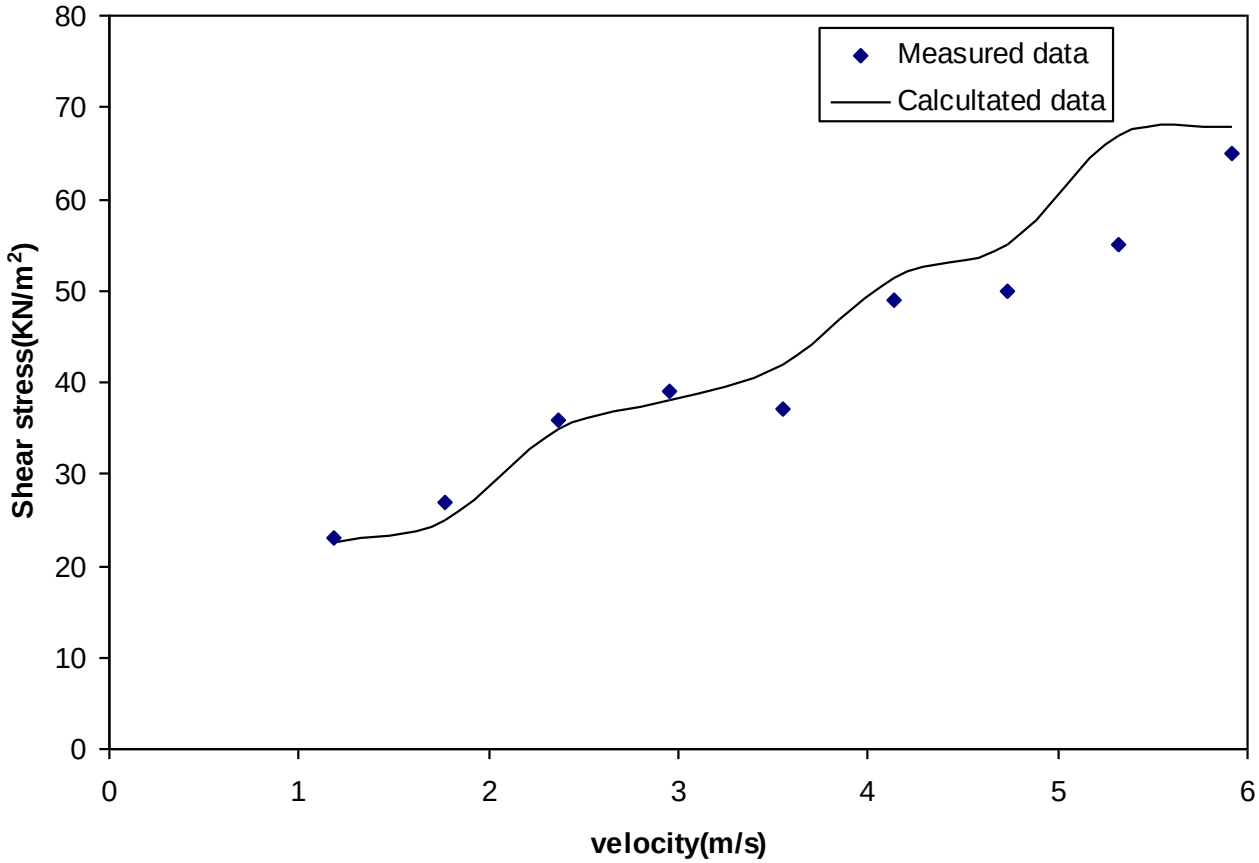
Analysis and discussion



Comparison of shear stress between measured data and calculated data for CG

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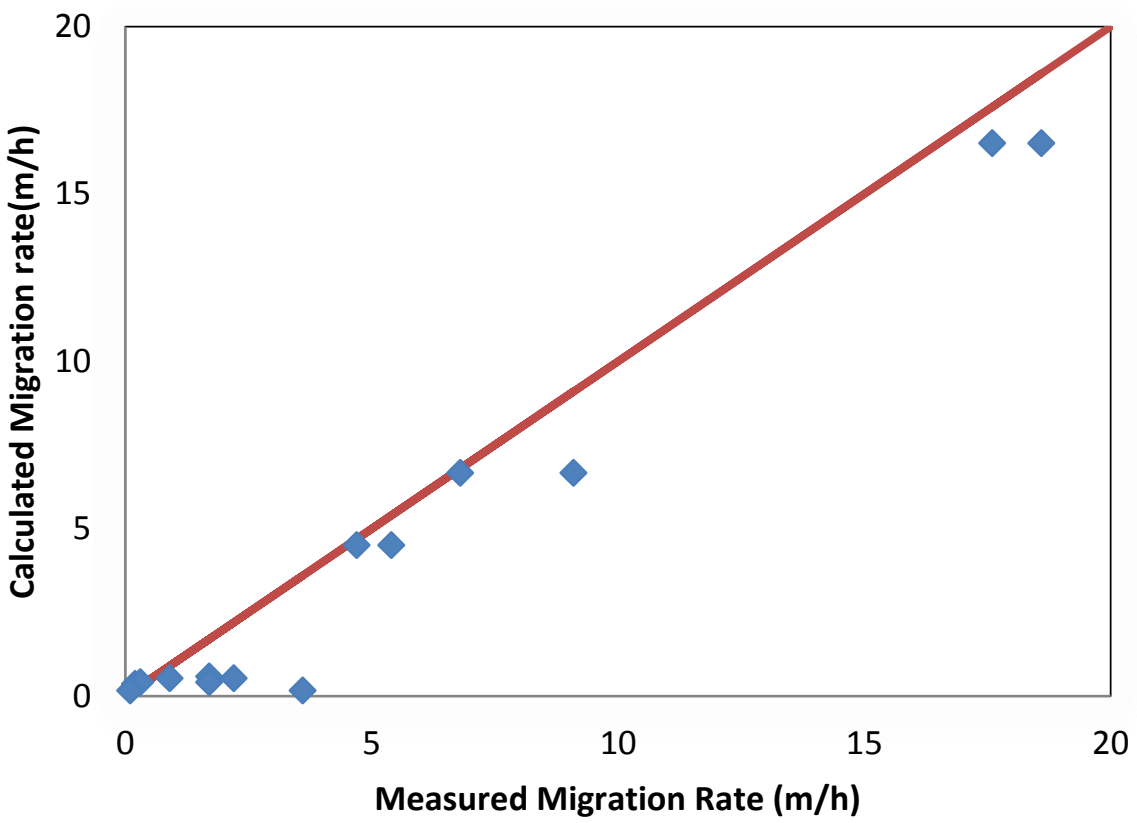
Migration rate



Comparison between Calculated and measured migration rate

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Conclusions

- **Headcut migration**

Geotechnical Problem and Hydraulic Problem

- **Critical shear Stress**

$$\frac{\tau_c}{(\gamma_s - \gamma)D} = C\frac{\tau_f}{\rho v^2}\theta_c$$

- **Headcut Migration Rate**

$$\frac{dx}{dt} = \frac{T}{f(T)}\varepsilon$$

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