

# Design criteria for sediment transport in sewers based on self-cleansing concept

Cite this as: Ebtehaj I., Bonakdari H., Sharifi A., 2014. Design criteria for sediment transport in sewers based on self-cleansing concept. *Journal of Zhejiang University-SCIENCE A (Applied Physics & Engineering)*, 15(11):914-924. DOI:10.1631/jzus.A1300135.



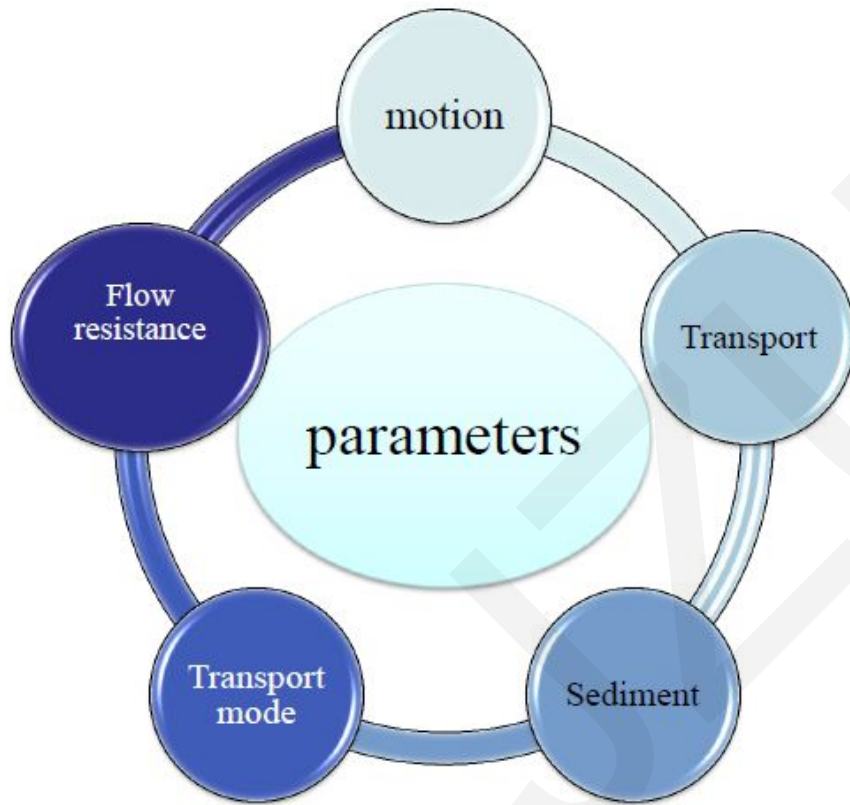
# Self-cleansing design concept

The self-cleansing process in the wastewater system must establish a balance between the amount of sediment and the rate of erosion during the sediment transport and, in a specific period of time, minimize the combined costs of construction, operation and maintenance of the system.

1- Design criteria  
for non-deposited  
sediment transport

2- Design criteria  
for limited deposit  
sediment transport

# Dimensionless parameters of sediment transport in clean pipe



Non-deposited sediment transport:

$$F_r = \frac{V}{\sqrt{gd(s-1)}} = f\left(\frac{d}{y} \text{ or } \frac{d}{R}, C_V\right)$$

Limited deposit sediment transport:

$$F_r = \frac{V}{\sqrt{gd(s-1)}} = f\left(\frac{d}{y} \text{ or } \frac{d}{R}, C_V, \frac{y_s}{D}\right)$$

# Non-deposited bed load

$$\text{May } et \text{ al. (1996): } C_V = 3.03 \times 10^{-2} \left(\frac{D^2}{A}\right) \left(\frac{d}{D}\right)^{0.6} \left[1 - \frac{V_t}{V}\right]^4 \left[\frac{V^2}{gD(s-1)}\right]^{1.5} \quad Eq.3$$

$$V_t = 0.125 [g(s-1)d]^{0.5} \left[\frac{y}{d}\right]^{0.47} \quad Eq.4$$

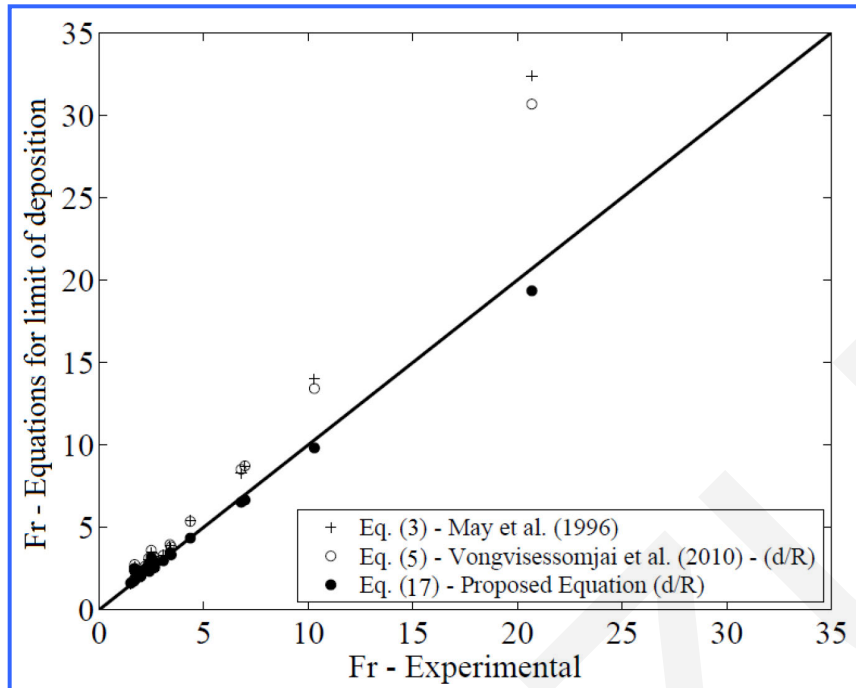
$$\text{Vongvisessomjai } et \text{ al. (2010): } \frac{V}{\sqrt{g(s-1)d}} = 4.31 C_V^{0.226} \left(\frac{d}{R}\right)^{-0.616} \quad Eq.5$$

$$\frac{V}{\sqrt{g(s-1)d}} = 3.57 C_V^{0.21} \left(\frac{d}{y}\right)^{-0.542} \quad Eq.6$$

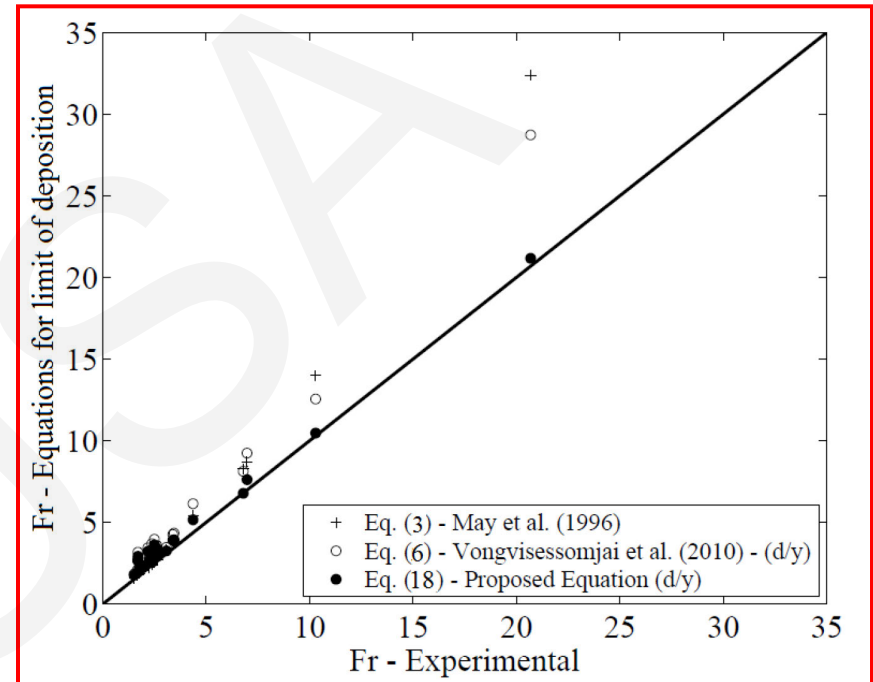
$$\text{Proposed equation: } F_r = 4.49 C_V^{0.21} \left(\frac{d}{R}\right)^{-0.54} \quad Eq.17$$

$$F_r = 3.59 C_V^{0.22} \left(\frac{d}{y}\right)^{-0.51} \quad Eq.18$$

# Non-deposited bed load: Results



Comparison of the proposed equation (17) for  $d/R$  with the equations of Vongvisessomjai *et al.* (2010) and May *et al.* (1996)



Comparison of equation (18) for  $d/y$  with equations of Vongvisessomjai *et al.* (2010) and May *et al.* (1996).

# Bed-load in deposited bed state

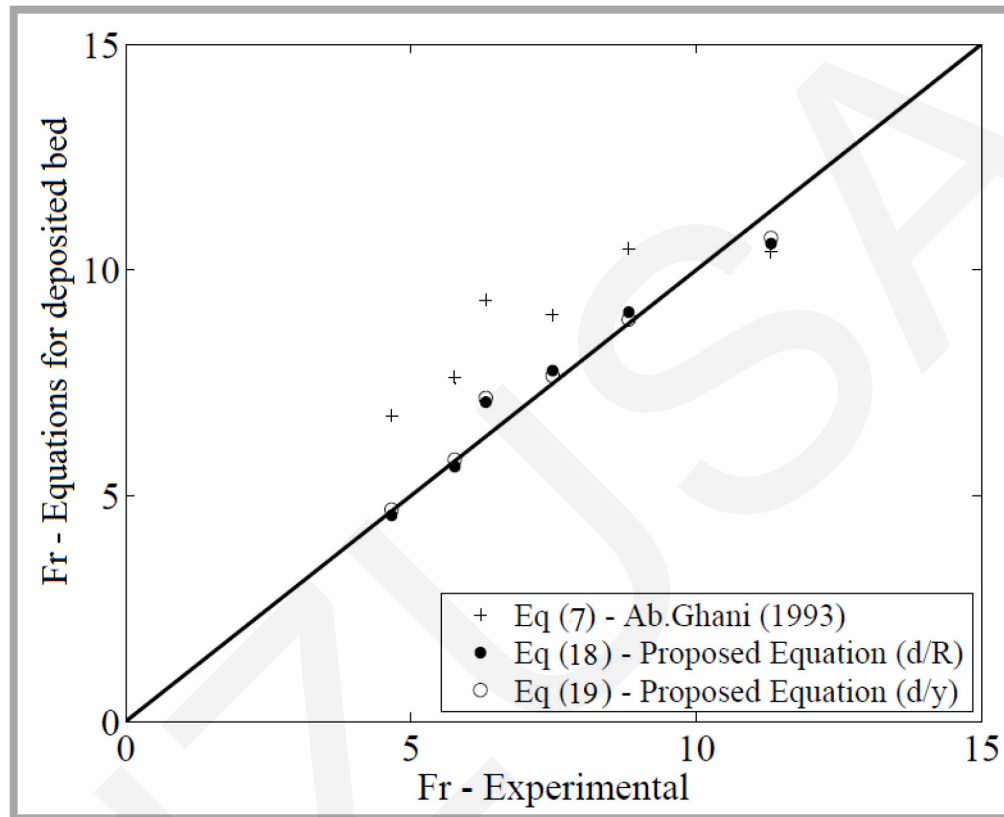
$$\text{Ab. Ghani (1993): } \frac{V}{\sqrt{g(s-1)d}} = 3.08C_V^{0.21} D_{gr}^{-0.09} \left(\frac{R}{d}\right)^{0.53} \lambda_s^{-0.21} \quad \text{Eq.7}$$

$$\lambda_s = 1.13\lambda_0^{0.98} C_V^{0.02} D_{gr}^{0.01} \quad \text{Eq.8}$$

$$\text{Proposed equation: } F_r = 2.5C_V^{0.375} \left(\frac{d}{R}\right)^{-0.766} \left(\frac{y_s}{D}\right)^{-0.258} \quad \text{Eq.18}$$

$$F_r = 2.8C_V^{0.335} \left(\frac{d}{y}\right)^{-0.482} \left(\frac{y_s}{D}\right)^{-0.463} \quad \text{Eq.19}$$

# Bed-load in deposited bed state: Results



Comparison of the Froude numbers from equations (18) and (19) and Ab. Ghani with the actual Froude number