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A simple formula for predicting settling velocity of sediment particles

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Abstract: Based on the general relationship described by Cheng between the drag coefficient and the Reynolds number of a particle, a new relationship between the Reynolds number and a dimensionless particle parameter is proposed. Using a trial-and-error procedure to minimize errors, the coefficients were determined and a formula was developed for predicting the settling velocity of natural sediment particles. This formula has higher prediction accuracy than other published formulas and it is applicable to all Reynolds numbers less than 2×10^5.

Key words: *settling velocity*; *spherical particle*; *sediment particle*; *sediment transport*; *trial-and-error method*

1 Introduction

The settling velocity of sediment particles, also called the terminal or fall velocity, is one of the key variables in the study of sediment transport and is important in understanding suspension, deposition, mixing and exchange processes. Nevertheless, it is still difficult to accurately predict the settling velocity, even for a single spherical particle. For its engineering application, the settling velocity for single particles, W_s , has been extensively studied. The drag coefficient, C_d, is inversely proportional to the particle Reynolds number, which is defined as $Re = W_s d / \nu$ (where Re is the Reynolds number, d is the particle diameter and ν is the fluid kinematic viscosity), when $Re < 1$ (Stokes flow). Later studies (Dallavalle 1948; Schlichting 1979) showed that C_d approaches a constant if $Re > 10^5$ (turbulent flow). If the effective weight is considered equivalent to the Newtonian expression of drag resistance, C_d can be defined as follows:

$$C_d = \frac{4}{3}\frac{\Delta g d}{W_s^2} \tag{1}$$

where $\Delta = \rho_s / \rho - 1$ (ρ_s and ρ represent the density of particles and the density of the fluid, respectively) , and g is the gravitational acceleration. There are two asymptotic equations of the settling velocity depending on the particle Reynolds number, i.e., $C_d = A/Re$ when $Re < 1$(Stokes flow) and $C_d = B$ when $10^5 < Re < 2\times10^5$ (turbulent flow), where A and B

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