Effect of diameter of stirring rods on mixing of different-sized particles

異なる粒度の粒状体の混合における撹乱ロッドの直径が及ぼす影響

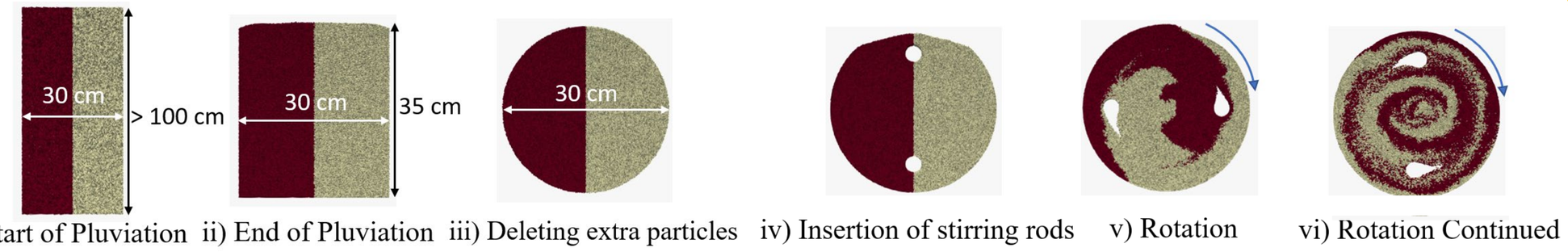
Introduction

This study intends to evaluate the effect of diameter of stirring rod on degree of mixture of two different size (i.e., gap-graded) particles mixed by the rotary action of these rods in a cylindrical soil specimen using discrete element method (DEM).

本研究は、円柱状粒状供試体の内部で攪拌ロッドの回転によって混合された粒度の異なる2種の粒状材料において、攪拌ロッドの直径が混合度に及ぼす影響を、個別要素法(DEM)によって評価した。

Simulation steps

Particle Properties
Inter-particle friction coefficient = 0.05
Young's modulus = 71.6 GPa
Poisson's ratio = 0.23
Diameter = 2 and 2.2 mm
Density = 2650 kg/m^3

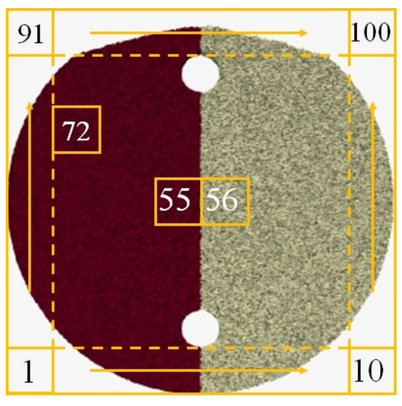


i) Start of Pluviation ii) End of Pluviation iii) Deleting extra particles iv) Insertion of stirring rods v) Rotation vi) Rotation Continued

Definition of degree of mixture

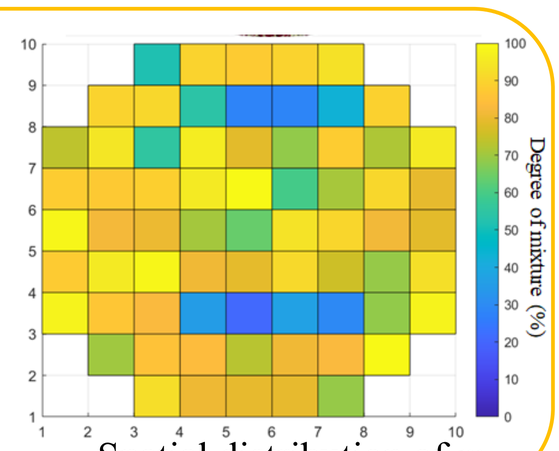
For **local degree of mixture (d_m)**, the particles were divided into the two regions (color 1 and color 2). The specimen was divided into one hundred equal-sized grids (10×10). For each grid, the d_m value was defined based on the difference in the volume occupied by type 1 and type 2 particles as follows.

$$d_m = \left(1 - \frac{|V_1 - V_2|}{V_1 + V_2}\right) \times 100$$



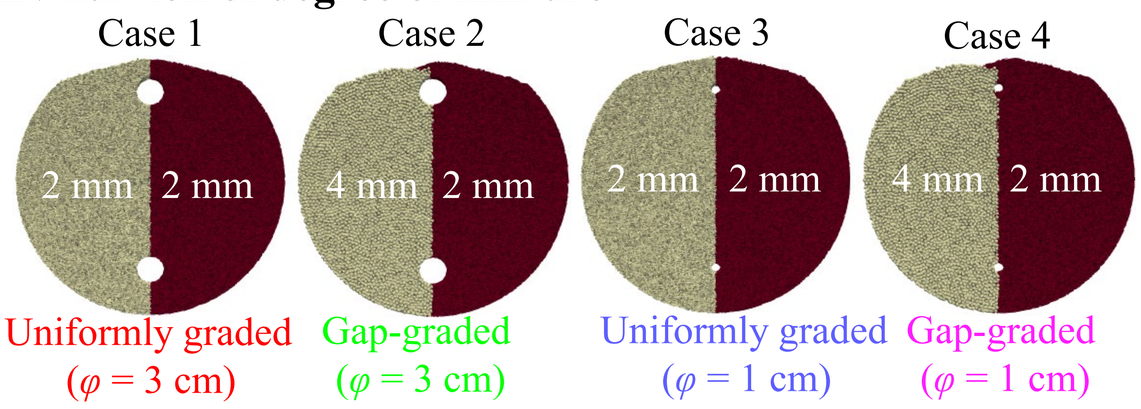
Grid system

Mixed specimen



Spatial distribution of m

Evaluation of degree of mixture



Fig, 1: Initial configuration of all cases.

Table: Test cases and specifications.

Case	Dia. of particles	Dia. of stirring rod, (φ)	No. of particles
	mm	cm	
1	2	3	165,919
2	2&4	3	107,484
3	2	1	169,398
4	2&4	1	109,809

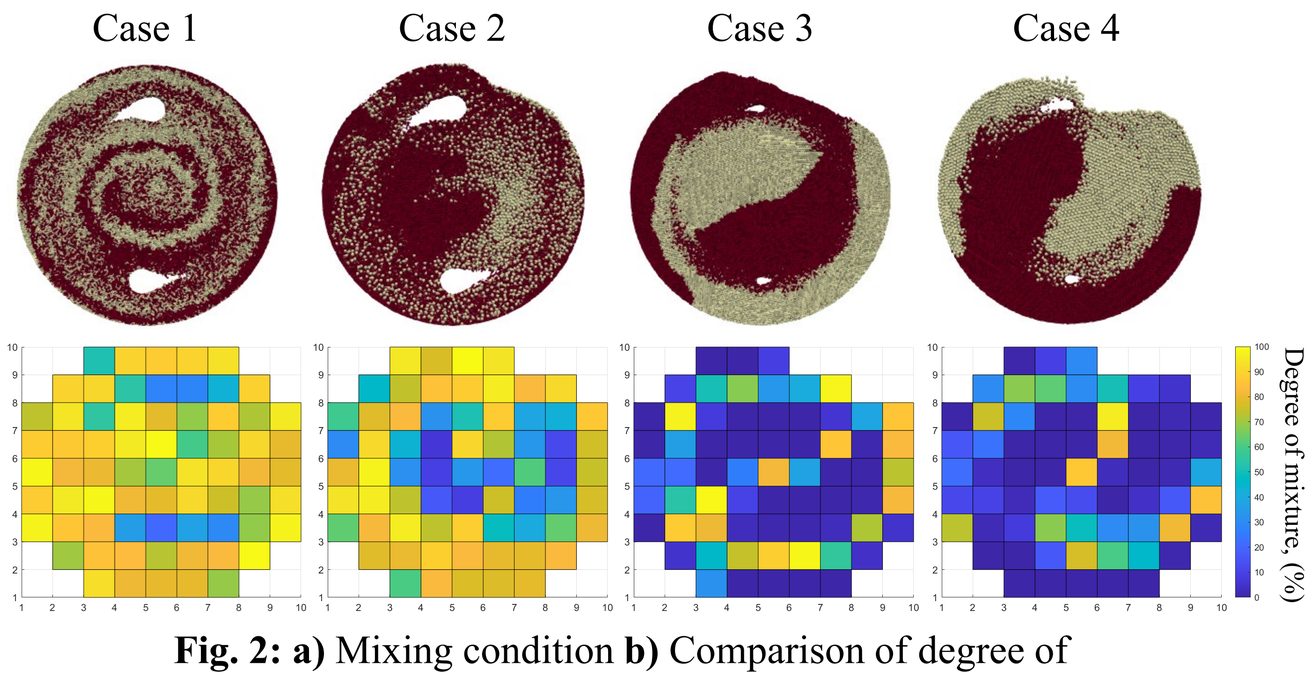


Fig. 2: a) Mixing condition **b)** Comparison of degree of mixture for all cases after 25 rotations.

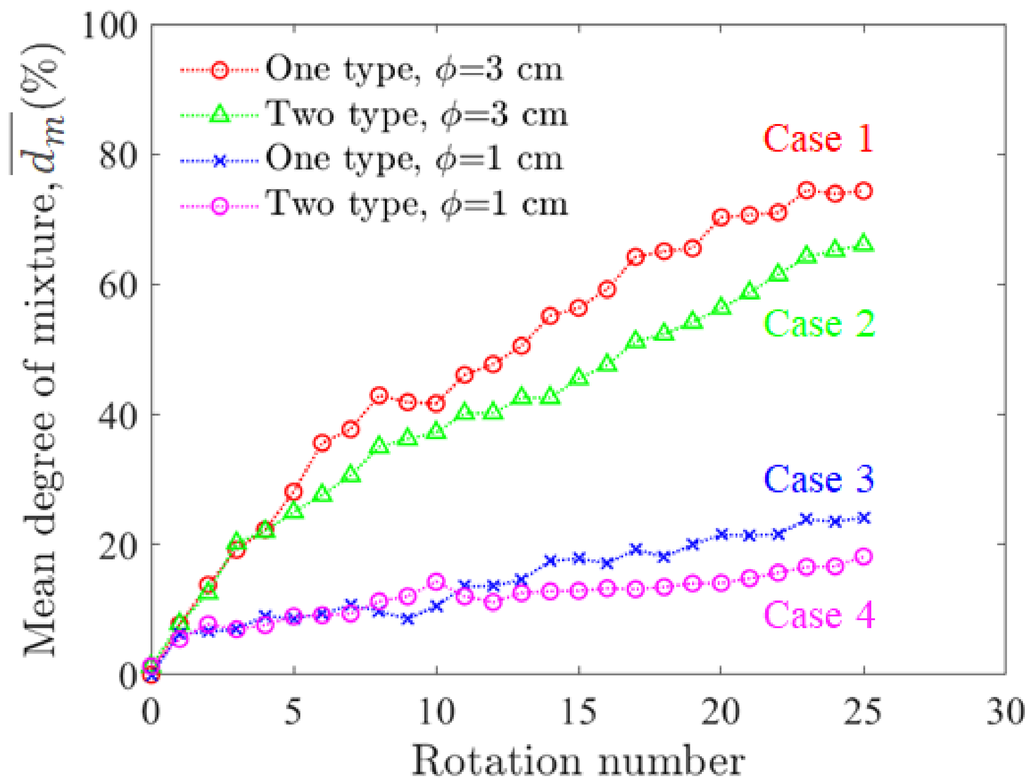


Fig: Mean degree of mixing of different diameter stirring rods for uniformly and gap-graded particles.

Conclusion

Mean degree of mixture is more sensitive to the size of stirring rods rather than the size of the particles being mixed, probably due to the less influenced zone generated by the motion of smaller rods during rotation. The $\overline{d_m}$ of gap-graded particles cases is slightly on the lower side as compared to that of uniformly graded particles.

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