Study on Deformation Mechanism of Saturated Sand Based on Discrete Element Method

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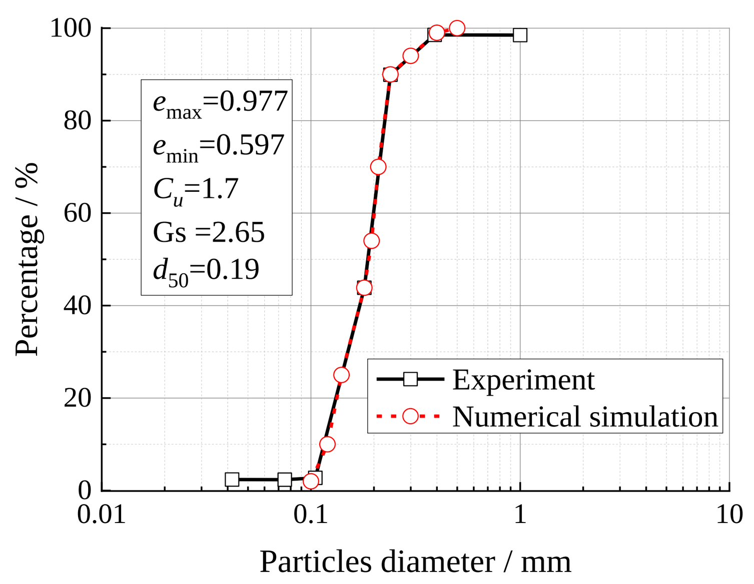
Introduction

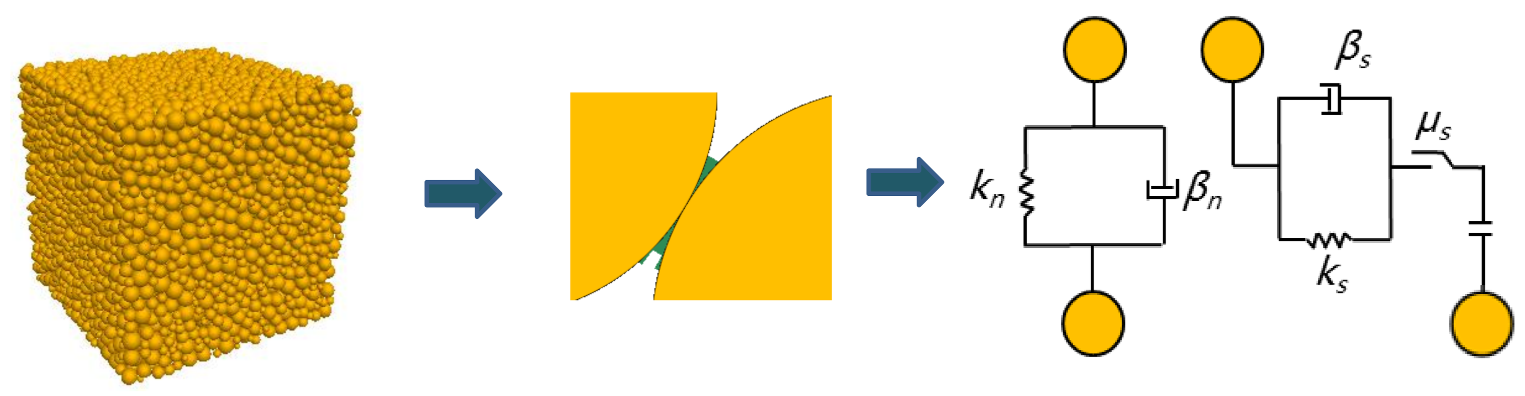
In the past, the shrinkage and dilatancy of sand have been assessed in terms of the increase and decrease of the total volume. Due to the discrete nature of the sand, localized shrinkage or dilatancy may have taken place in localized areas of the sample, while the overall bulk strain is not visible. Therefore, it is necessary to reveal the shrinkage and dilatancy phenomenon of saturated sand from a microscopic perspective.

Objective

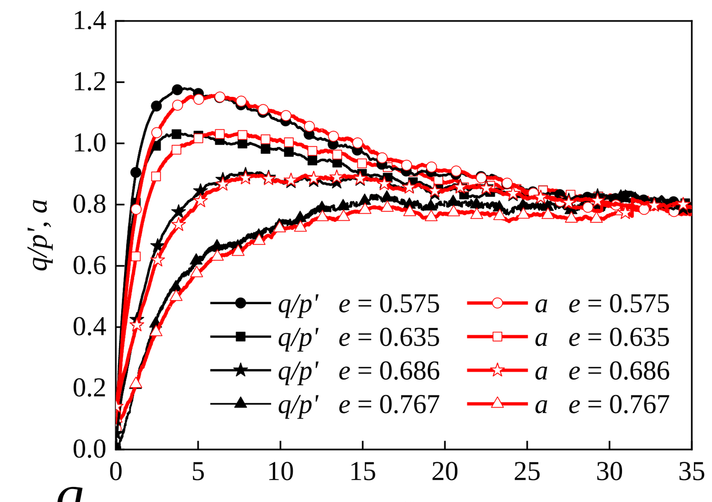
- The macro and micro mechanical behavior and deformation properties of samples with different initial void ratios in drained tests are analyzed.
- The contribution weight of the anisotropy coefficient to shear strength is analyzed, and its correlations with the phase transition state and critical state are discussed.
- Evolution process of the velocity field, rotation field, and damping energy from shrinkage to dilatancy of the sand are exhibited.

Methode





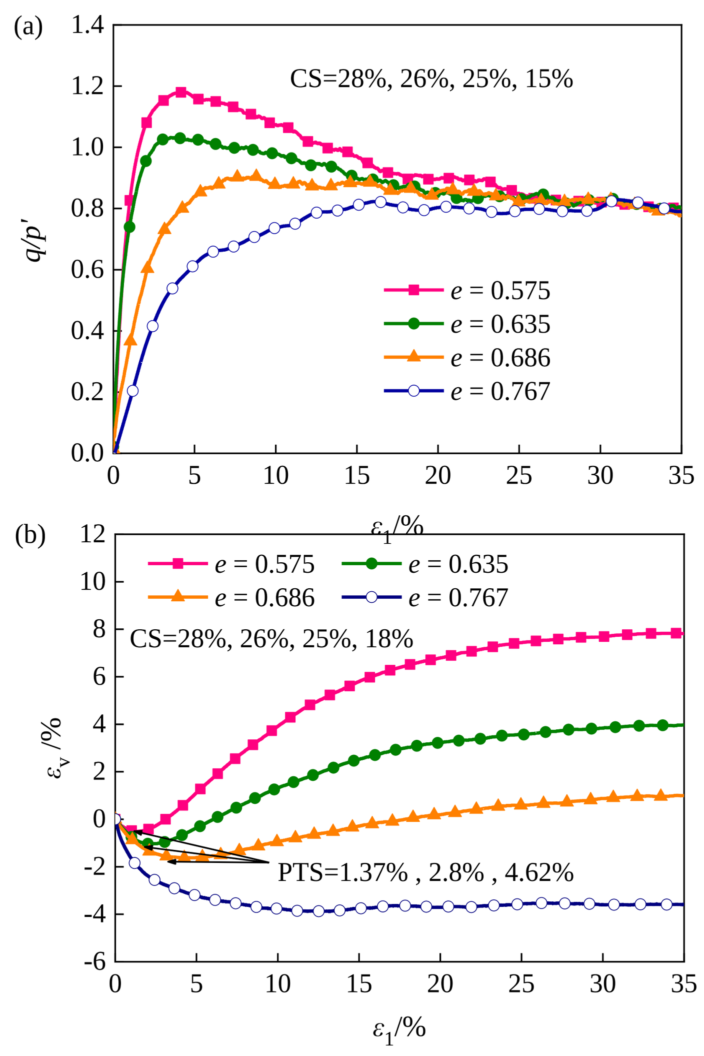
Numerical model



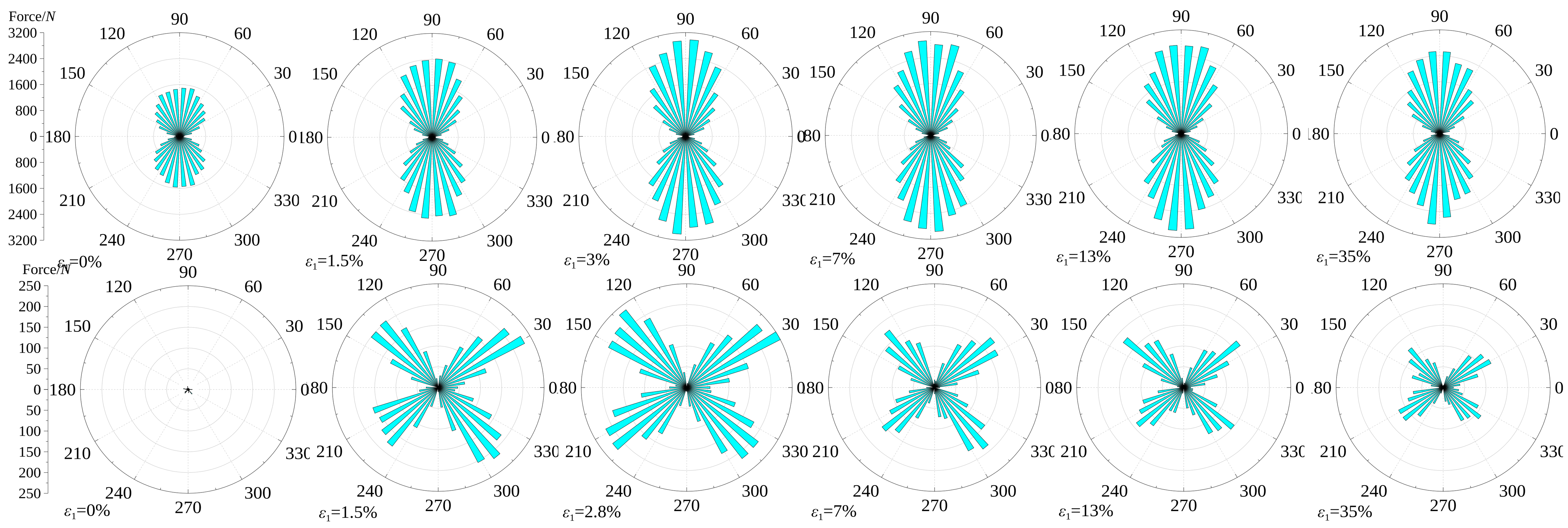
$$\frac{q}{p'} = 0.4a_c + 0.4a_d + 0.4a_n + 0.6a_t$$

Results

Macroscopic behavior

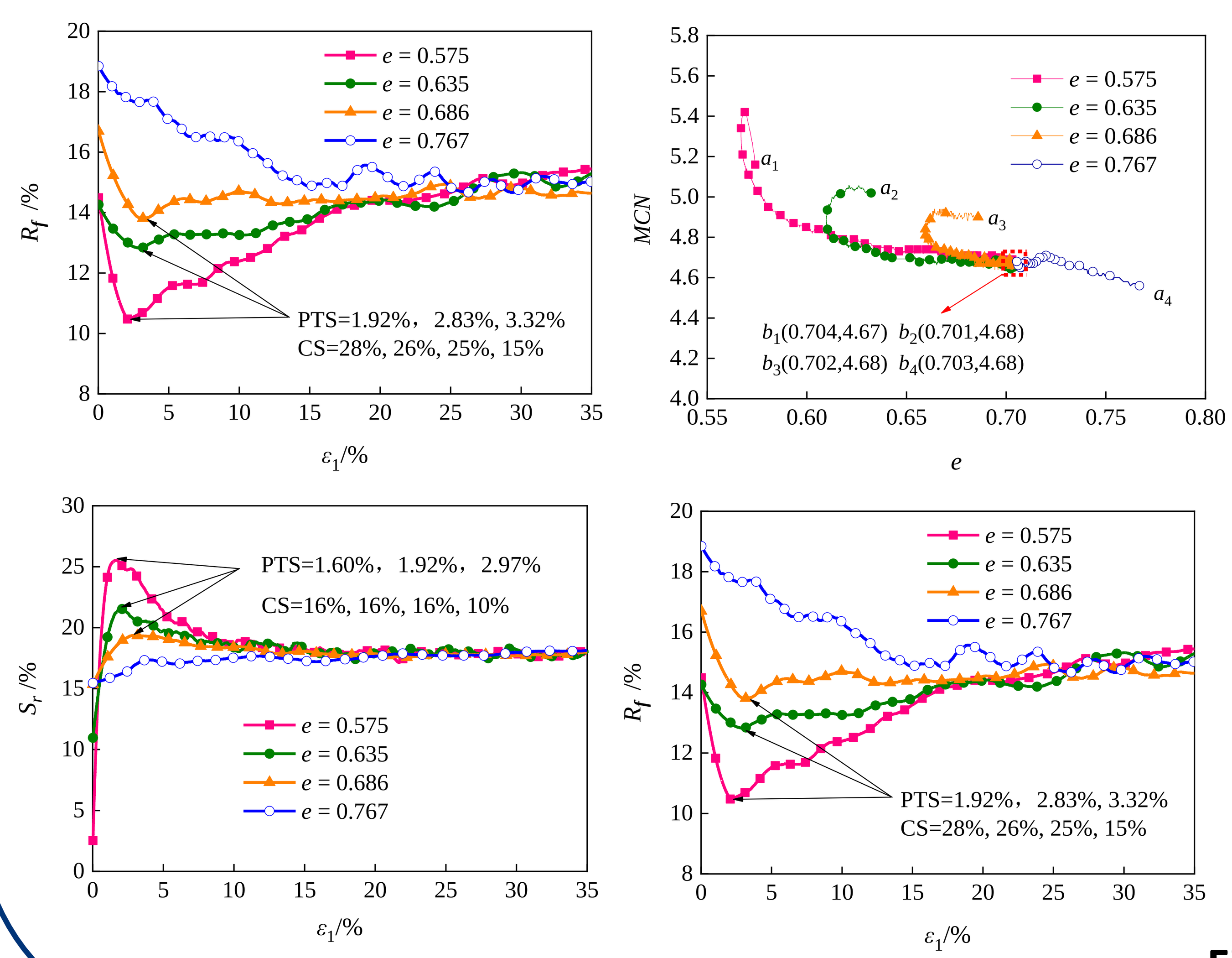


Rose chart of contact forces between particles (a)Normal contact force;(b)Tangential contact force



The intergranular contact force reaches the maximum at the phase transition state (ε_1=2.8%). Before the phase transition state (ε_1=2.8%), the intergranular forces increase continuously, shear shrinkage occurs. When the normal and tangential contact forces gradually decrease ,the soil changes from shear shrinkage to dilatancy.

Microscopic behavior



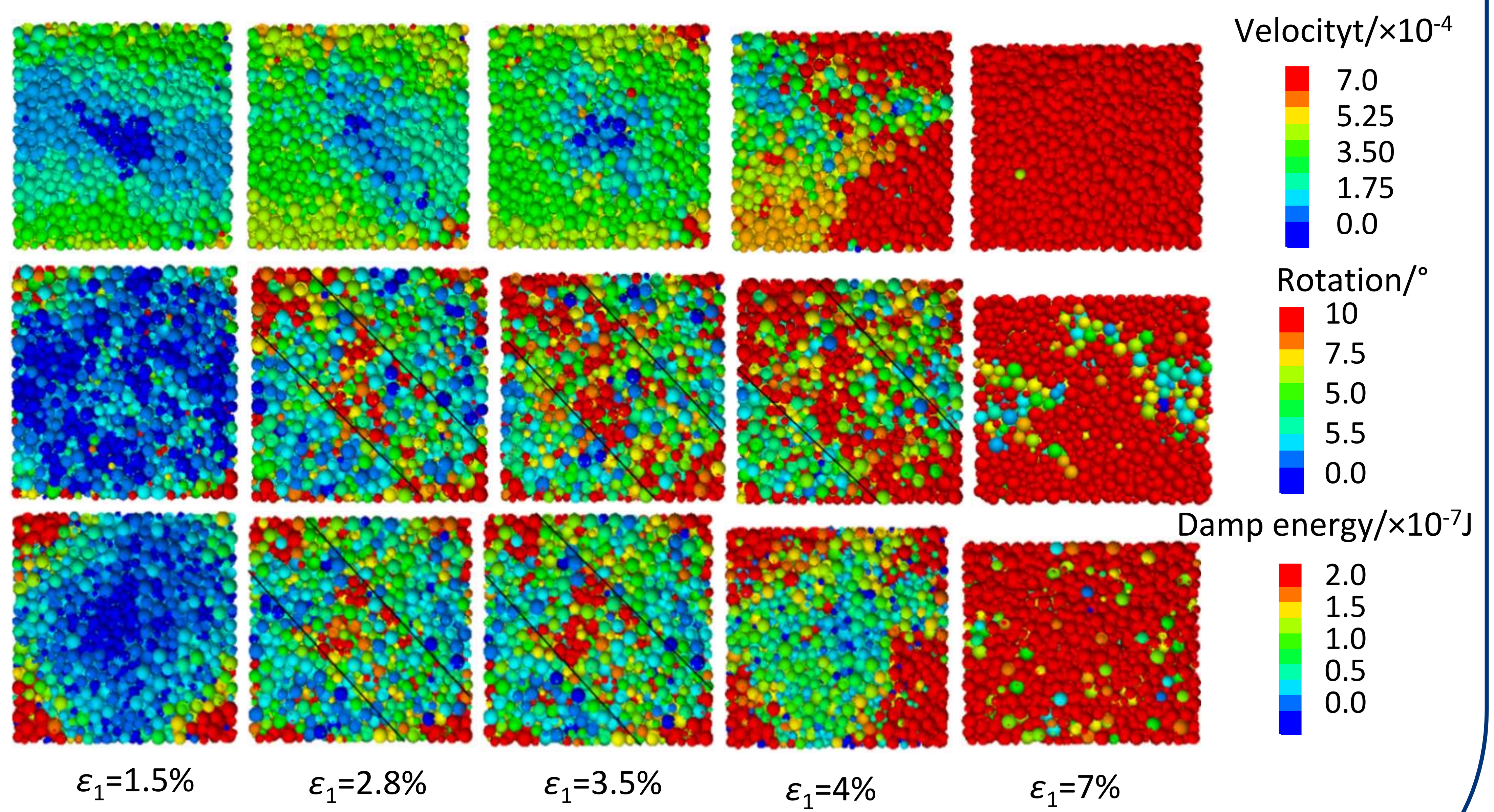


Figure 10. Evolution process of particles: (a)Velocity field; (b) Rotation field; (c) Damping energy

Conclusions

The phase transition state of saturated sand can be reflected by the extreme values of void ratio, sliding ratio, suspended particle ratio and mechanical coordination number. The microscopic parameters can reveal the critical state of saturated sand earlier than the macroscopic parameters. The evolution process of rotation field and damping energy show that the particle collision on the 45° shear surface is intense. The particle motion in the diagonal range is dominated by rotation.

References

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