Numerical Study on Load-Settlement Relationships of Shallow Foundation under Extremely Low Confining Pressure

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ABSTRACT

Foundation stone has been employed for thousands of years to support historical structures. The foundation stone support system is basically composed of a base ground, foundation stones, and an upper structure. Self-weight of an upper structure is transferred from structural columns to a base ground through foundation stones. In this support system, main purpose of foundation stones is to distribute a concentrated column force in a foundation stone body, relaxing stress concentration at the bottom of columns.

In this support system, foundation stones often penetrate into a base ground once they are undergoing additional external forces such as earthquakes because surface grounds around foundation stones don't have enough bearing capacity due to an extremely low confining pressure condition. Conventional bearing capacity theory is employed when it can be regarded as it be under the small deformation condition whereas it becomes difficult to evaluate bearing capacities and to predict settlements under the large deformation condition such in case of foundation stones. The conventional method is based on an assumption of rigid-plastic behaviour and it focuses on a bearing capacity at an ultimate state. Therefore, the same approach cannot be applied to the case under large deformation conditions, which include geometrical nonlinearity.

In order to assess the support system behaviour under extremely low confining pressure, experimental and numerical study are the main options to be chosen. Experimental testing is performed and reported in the companion papers by the same authors, demonstrating that a load-settlement relationship under large deformation condition shows mush higher bearing capacity than the case of small deformation condition, demanding incremental external force for a footing to settle. In this paper, the demonstration of the applicability of numerical simulation is to be focused, employing a particle-based numerical method, which have been applied to geomaterial literally [1]. A shallow foundation model is set up numerically, in which footing foundation is modelled as elastic and a base ground is modelled as elasto-plastic material with Mohr-Coulomb failure criteria. Then, the support system behaviour is assessed by comparing the experimental results with the simulation results.

From comparison between experimental and numerical results, the load-settlement relationship by both methods gives a good agreement to each other, meaning particle-based numerical method is capable of simulating the behaviour of the support system under extremely low confining pressure.

REFERENCES

[1] D. Sulsky, Z. Chen and H.L. Schreyer, A particle method for history-dependent materials, *Computer Methods in Applied Mechanics and Engineering*, 118, 179-196, (1994).