論 文 内 容 の 要 旨

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Presently, there are many formulas used to calculate the ultimate bearing capacity such as Terzaghi (1943) and others (e.g. Meyerhof, 1951, 1963). However, the formula has disadvantages in application to practice since it is only applied in calculating simple footing shape and uniform grounds. Most formulas don't take into account the size effect of footing on ultimate bearing capacity except for the formula by Architectural Institute of Japan. The advantage of finite element method is the application to non-uniform grounds, which are for example multi-layered ground and improved ground, and complicated footing shape in three dimensional condition. It greatly improves the accuracy in estimating ultimate bearing capacity. Moreover, limit state analysis is possible to be conducted without the assumption on potential failure modes. The objective of this study is proposing a rigid plastic constitutive equation using non-linear shear strength property against the confining pressure. The constitutive equation was built based on the experiment regarding non-linear shear strength property against confining pressure reported by Tatsuoka and other researchers. The obtained results from experiment on Toyoura sand and various kinds of sands indicated that although shear resistance angle differs among sandy soils, the normalized shear resistance angle decreased with the increase in the normalized first stress invariant for various sands despite of dispersion in data. It was shown no matter how to select the standard value of confining stress in normalization of shear resistance angle. This equation is expressed by the higher order parabolic function and easily applied to RPFEM. Applicability of proposed rigid plastic equation was proved by comparing with the ultimate bearing capacity formula by Architectural Institute of Japan (AIJ, 1998, 2001) which is an experimental formula to take into account the size effect of footing.

Size effect of footing is observed in ultimate bearing capacity, but basically not accounted in the ultimate bearing capacity formulas. In this study two discussions on the size effect were conducted. One is the size effect in case of a uniform sandy ground and the other is in case of a multi-layered ground. The results of RPFEM with the proposed constitutive equation were obtained similar to the results by Architectural Institute of Japan. It is clear that RPFEM with the use of non-linear shear strength against the confining pressure provides good estimations to the ultimate bearing capacity of footing by taking account of size effect of footing. RPFEM was clearly shown to be effective for the complicated problems in material properties and footing shape than the conventional ultimate bearing capacity analysis.

The size effect of footing in ultimate bearing capacity is also observed in case of multi-layered ground. In conventional methods, it is difficult to assess the ultimate bearing capacity for multi-layered ground due to the complexity in failure mode of ground. RPFEM is, however, applicable boundary value problems. Through the case studies for various footing widths, the

change in both ultimate bearing capacity and failure mode due to footing width is shown properly simulated.

Moreover, due to bending moments and horizontal thrusts transferred from the superstructure or earthquake, strip foundations are often subjected to inclined loads and combined loading. RPFEM is used for the assessment of ultimate bearing capacity of footing on sandy soils against the combined load of vertical, horizontal and moment loads. The numerical results were compared with the results predicted by semi-empirical bearing capacity formulate of Meyerhof and others.