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SSS28-18 Room:303 Time:May 23 11:45-12:00

Numerical analysis of failure of soil ground due to surface loading and generation of vibration induced by the failure

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In modern soil mechanics/geo-mechanics, the failure of soil ground has been analyzed as a progressive failure, in which elasto-plastic nature is introduced for the soil behavior. The main target of the analysis is the prediction of both the shape and the location of strain localization area in the ground and they intend to observe, through computation, how the strain localization area develops progressively with time and with space. The analysis is then somewhat different from the conventional slip failure analysis in which the shape and the location of failure zone and/or slip line are usually considered as given conditions for the analysis[1), 2)].

In this study, the so called "bearing capacity problem" in soil engineering is newly analyzed as an example problem of the progressive failure of soil ground, in which vibration behavior of the ground is first observed, through computation, during the whole procedure of progressive failure. The numerical analyses are performed using the soil-water coupled finite deformation analysis code ***GEOASIA***[3)] that mounts the SYS Cam-clay[4)] elasto-plastic soil model on it. In the analysis, since the rate type equation of motion is precisely time-integrated, then progressive failure will be completely analyzed as a nonlinear dynamic problem.

First considered was the case of "displacement control loading" in which loading to the ground is applied with constant rate of displacement of foundation. In this case, the soil ground exhibited localization of deformation and formation of a circular arc-shaped slip failure. At the same time "load reduction" was also observed with the development of failure zone. To the same soil ground, surface load was next applied by the "load control" method. In this case, after the applied load reached the peak load, the soil ground suddenly failed and dynamic motions with acceleration were observed at the foundation under the same amount of applied load. Very much irregular vibration was also observed in surrounding ground due to the "shock" of the failure[5)]. In the vibration, very high frequency components were found to dominate, the reason for which will be due to the small scale of foundation. Focused on this point, the analysis objects were next scaled up 300 times big (from 8m high and 96m wide to 2.4km high and 24.8km wide). In this case, the dominant period of the vibration acceleration in surrounding ground shifted from about 0.2-0.3 seconds to about 5-8 seconds, keeping the amount of maximum acceleration almost the same. The descent of shear stress in slip/failure region that led to both the "load reduction" and the dynamic motion of foundation will be delivered later.

Recently, geo-materials have been obtained from deep subduction zone of huge plates. Although the authors have not seen such geo-materials yet, they intend to make research works that describe the change of elasto-plastic properties of such geo-materials that should have occurred due to the subduction zone slip failure using the computational elasto-plastic geo-mechanics.

References:

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Keywords: progressive failure, vibration, soil ground, elasto-plastic geo-mechanics, inertial force

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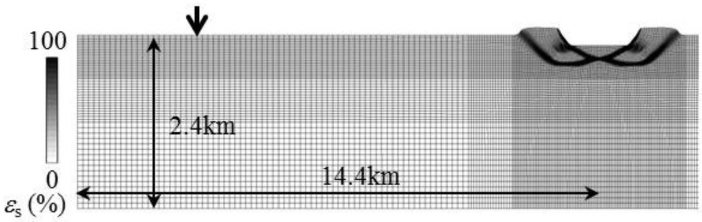

Fig. 1. Failure of ground with strain localization

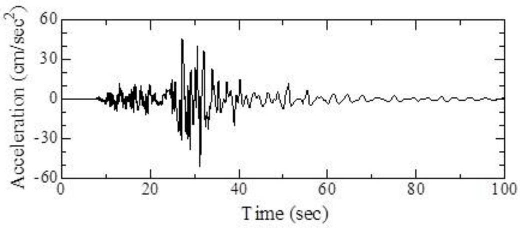

Fig. 2. Vibration in surrounding ground due to the shock of failure (at the point indicated by the arrow in Fig. 1.; vertical direction)