Analysis of deformation and response of various grounds during earthquakes (One dimensional ground model)

One dimensional ground model is adopted for analyzing horizontally layered ground, of which properties vary in one direction (vertical direction) but do not vary in other direction (horizontal direction). This model is equivalent to one soil column with a unit width cut out from the horizontally layered ground and representing the behavior of whole ground during earthquakes.

【Example: ground response and settlements at Port Island site】

One dimensional analysis is performed on behavior of ground at Port Island site during 1995 Hyogoken-Nambu earthquake using FLIP ROSE with cocktail glass model element (partially drained analysis).

The ground is made of land fill with decomposed granite and the quay walls at Port Island suffered serious damage due to liquefaction. Liquefaction caused wide spread settlements of several tens of centimeters throughout the Island (Fig. 1).

Fig. 1 Settlements of ground at Port Island during 1995 Hyogoken-Nambu earthquake

The land fill of decomposed granite from the ground surface to GL-13.6m is idealized into four layers as shown in Fig. 2 and idealized by cocktail glass model (partially drained analysis) for one dimensional analysis.

Analysis by FLIP ROSE 2D results in the vertical displacement and horizontal acceleration at ground surface as shown in Fig. 3. The computed ground settlement is about 30cm and consistent with those measured at the site.

The analysis results in the effective stress paths shown in Fig. 4 for decomposed granite1 through 3. The analysis results in the excess pore water pressure distributions and time histories are shown in Fig. 5.

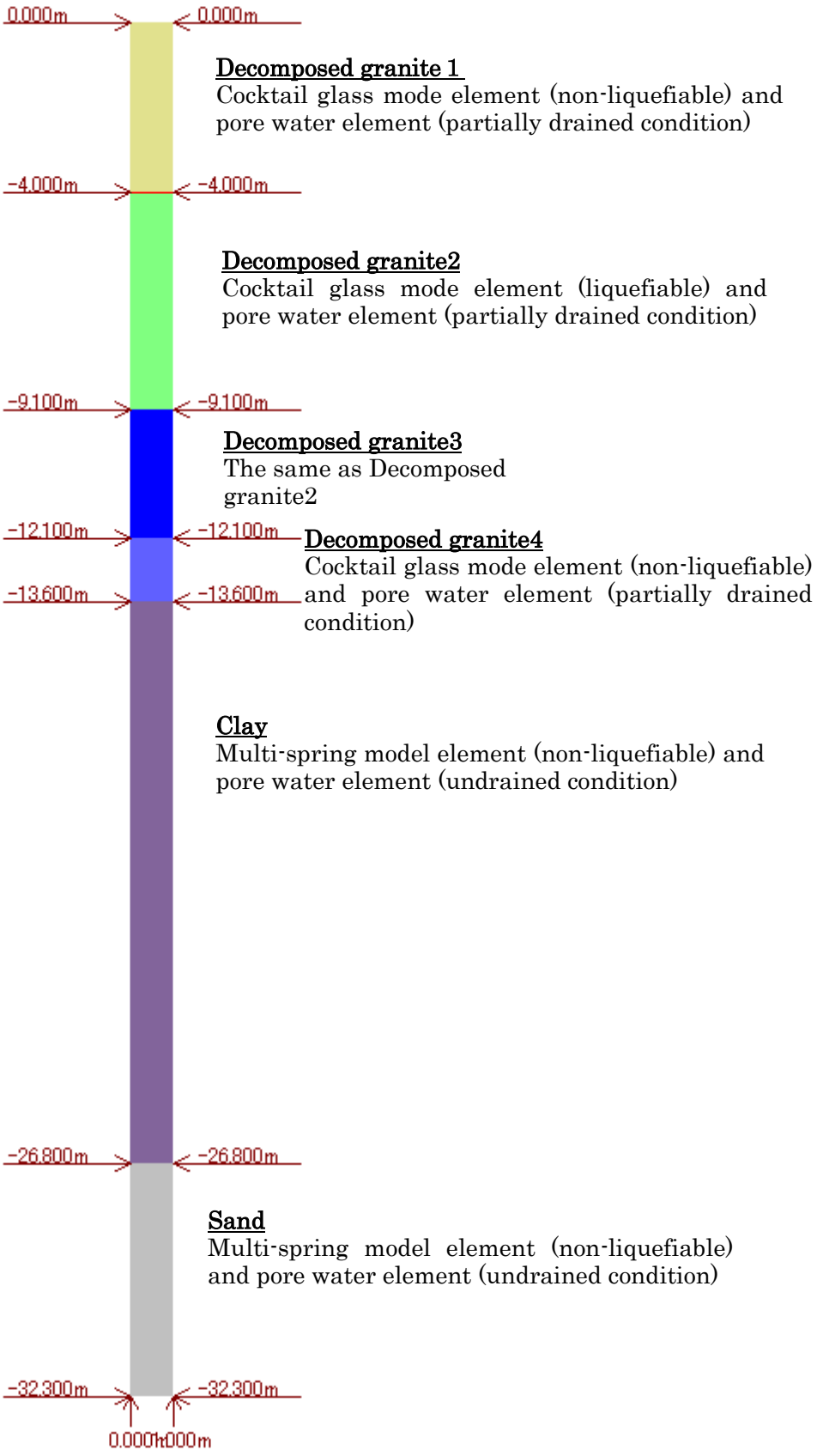


Fig. 2 One dimensional ground model of Port Island site

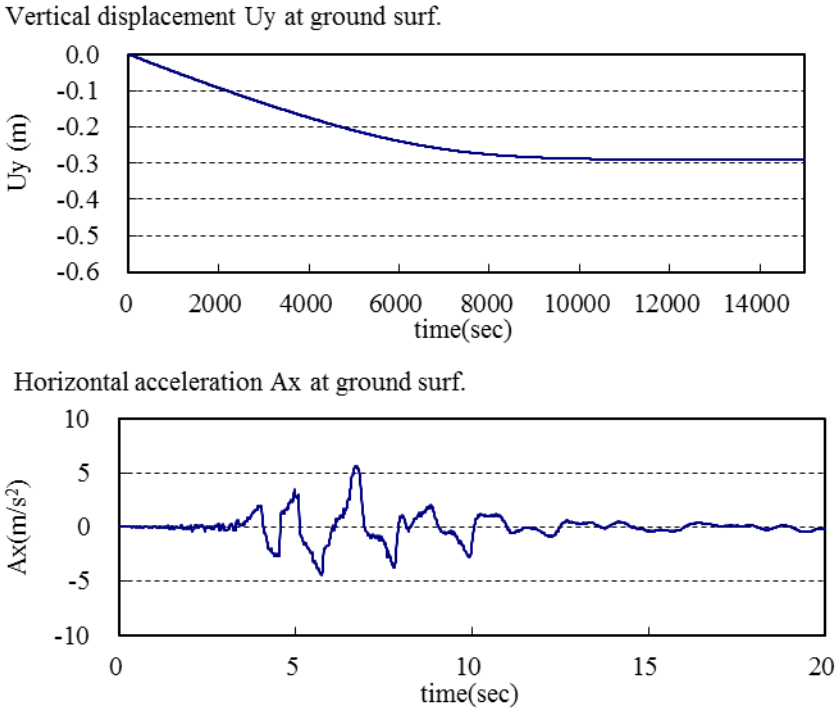


Fig. 3 Computed vertical displacement (upper) and horizontal acceleration (lower) at the ground surface

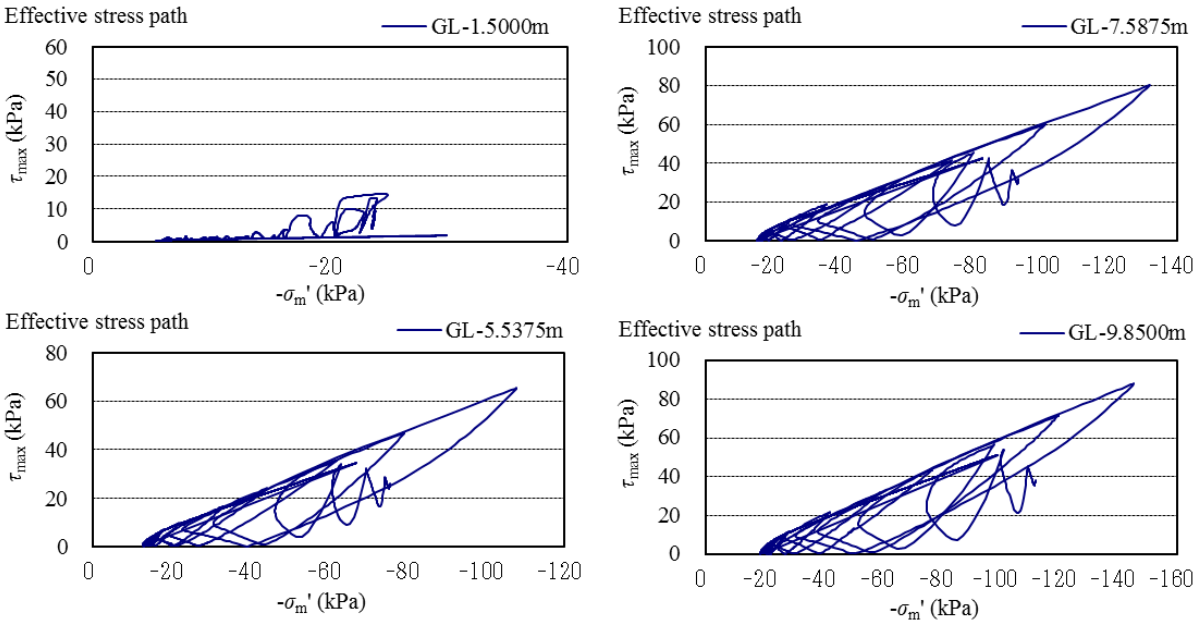
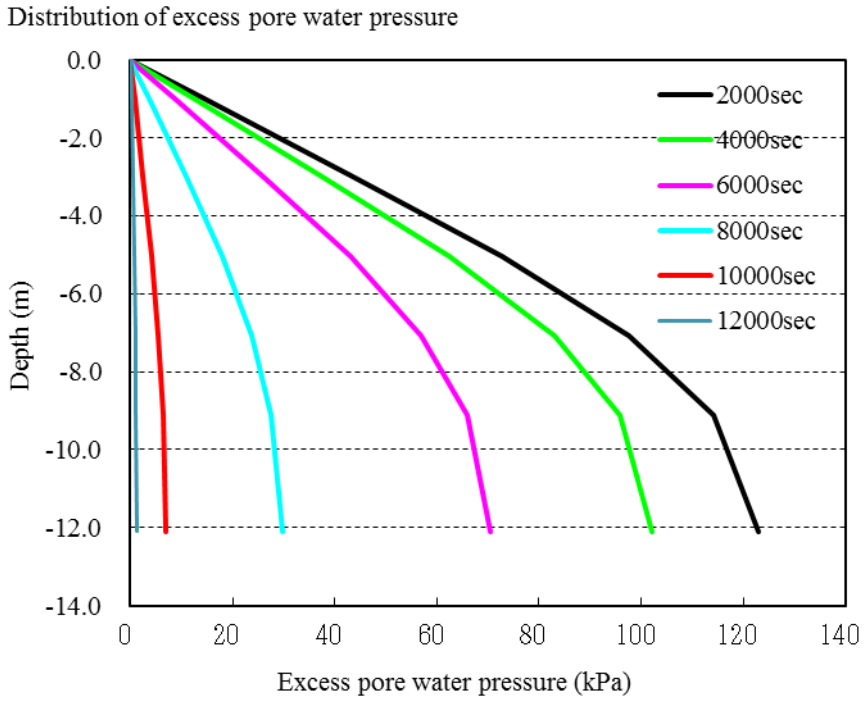


Fig. 4 Computed effective stress paths of decomposed granite

Upper left: decomposed granite1, Lower left: upper decomposed granite2,
Upper right: lower decomposed granite2, Lower right: decomposed granite3



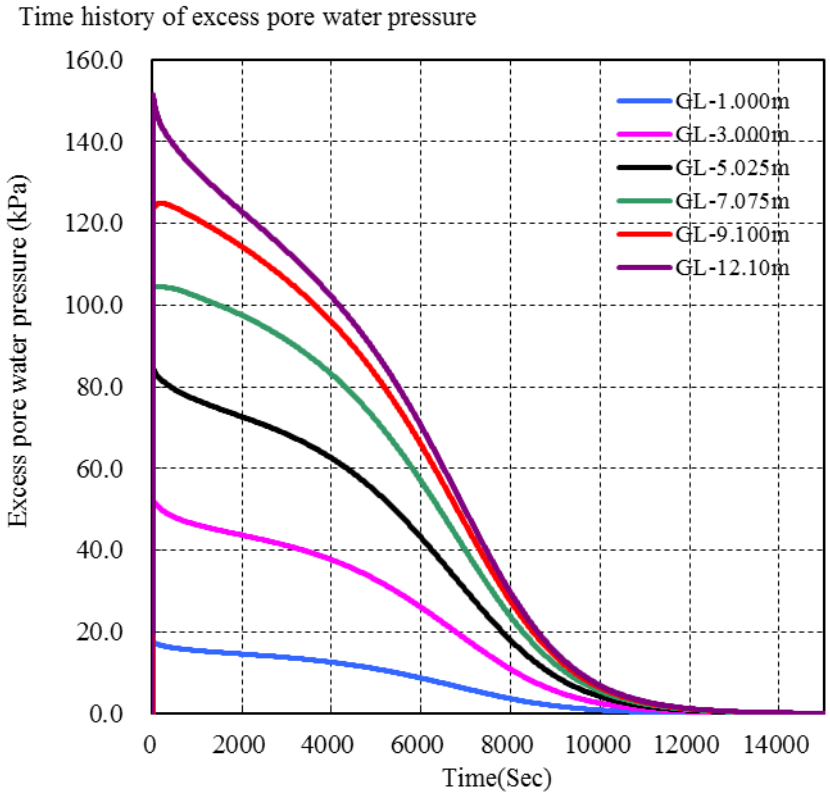


Fig. 5 Computed excess pore water pressure distribution at every 2000s step (upper) and time histories of excess pore water pressures at each depth