Final Examination Stability Analysis in Geotechnical Engineering

(by Dr J. Takemura)

6th February 2006

1. Fig. 1 shows the horizontal and vertical displacements of adjacent gravity type caisson quay walls caused by 1995 Kobe Earthquake with different foundation conditions (Fig.2). Answer the following questions.

(1) Explain the difference of damages of the quay walls with two foundations.
(2) Explain the mechanism of the large displacement of the caisson founded on the replaced sand.
(3) Propose the effective remedial methods to prevent the liquefaction of the sand for this type of ground condition for the case i) the caisson can be removed, and case ii) the caisson cannot be removed.
(4) In order to improve the seismic stability of the caisson as high seismic resistant quay wall, what kind of retrofitting can be considered?

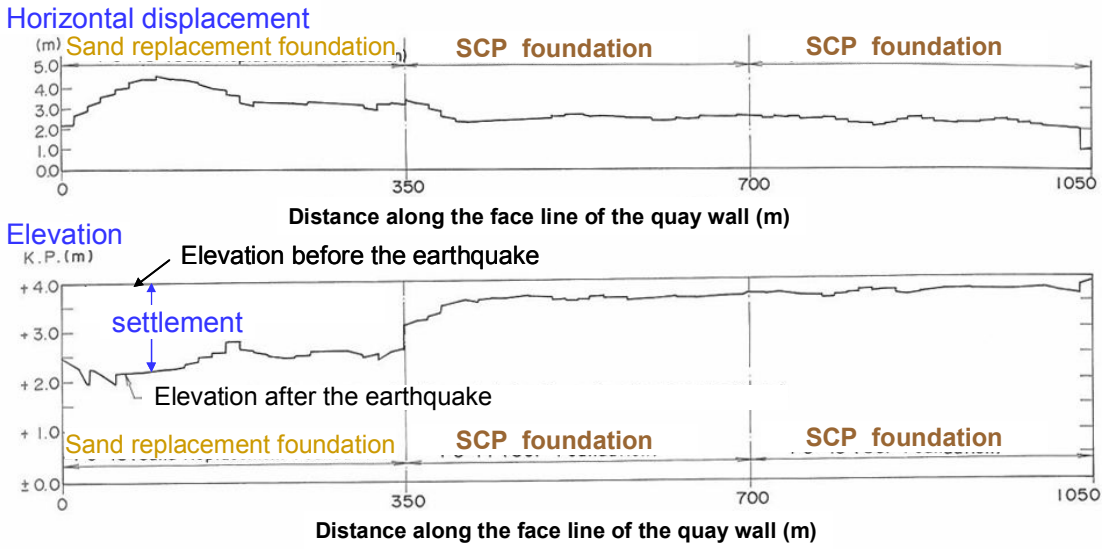


Fig.1 Displacement of the quay walls with the two different foundations shown in Fig.1

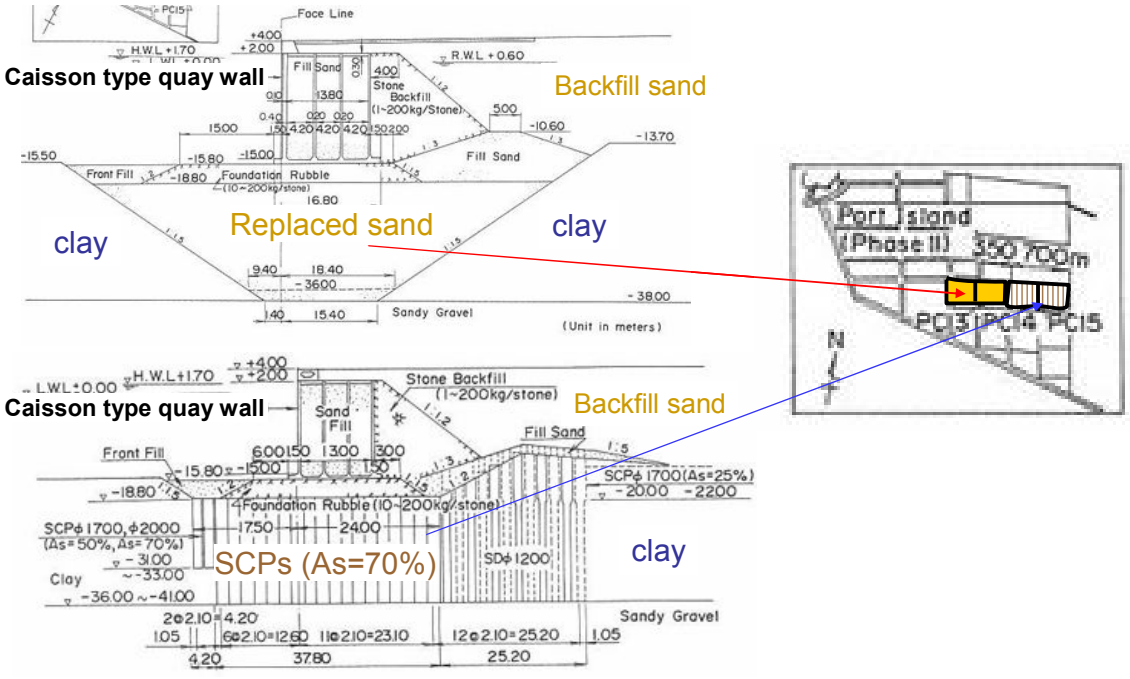
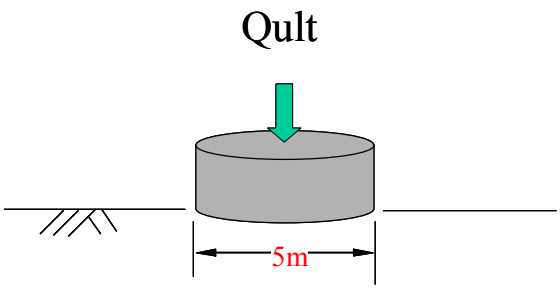


Fig.2 Cross sections of two adjacent quay walls with different foundation condition at Port Island

2. Consider the rigid circular surface foundation (diameter: 5m) on dense dry sand shown in Fig.3. The sand has specific gravity Gs=2.7, dry unit weight γ_d=16kN/m^3 and effective friction angle ϕ'=40^o. This friction angle was obtained from a triaxial test. Assuming unit weight of water γ_w=10kN/m^3, answer the following questions.

(1) How much is the void ratio of the sand?
(2) Evaluate the ultimate bearing load of the foundation.
(3) If the sand has ground water level at the surface, how much does the bearing capacity of the foundation change?
(4) When the sand is very loose with friction angle is 35^o, how do the failure mechanism, the load - settlement curve and the ultimate bearing capacity change from those of the dense sand?
(5) Which ultimate bearing intensity (stress) is greater, rigid circular footing with diameter of 5m or rigid rectangular footing with width of 5m and length of 25m? Explain the reason of the answer as well.



Dense sand (Gs=2.7)
γ_d=16kN/m$_3$,
ϕ'=40^o which is evaluated from triaxial test.
γ_w=10KN/m^3

Fig.3