Class B prediction of spread foundation settlements in large-scale liquefaction shaking table experiment

PEER Blind Prediction Contest 2018

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Summary: Time histories of absolute settlement values at free-field and shallow foundation in liquefied soil in shaking table test were predicted by numerical analysis based on a strain space multiple mechanism model (Iai et al.,1992) using the program “FLIP TULIP Ver.6.4” (Iai et al., 2013). Numerical analysis was conducted using two dimensional (2D) finite element analysis model by applying the measured horizontal acceleration time history at the bottom. Model parameters of liquefied loose layer of Ottawa sand were assessed for physical, dynamic deformation and liquefaction characteristics based on variety of laboratory tests (Bastidas, 2016) and other literal values (e.g. Ishihara, 1997). It is noted that residual strength was considered for loose liquefiable layer to simulate steady state of soil.

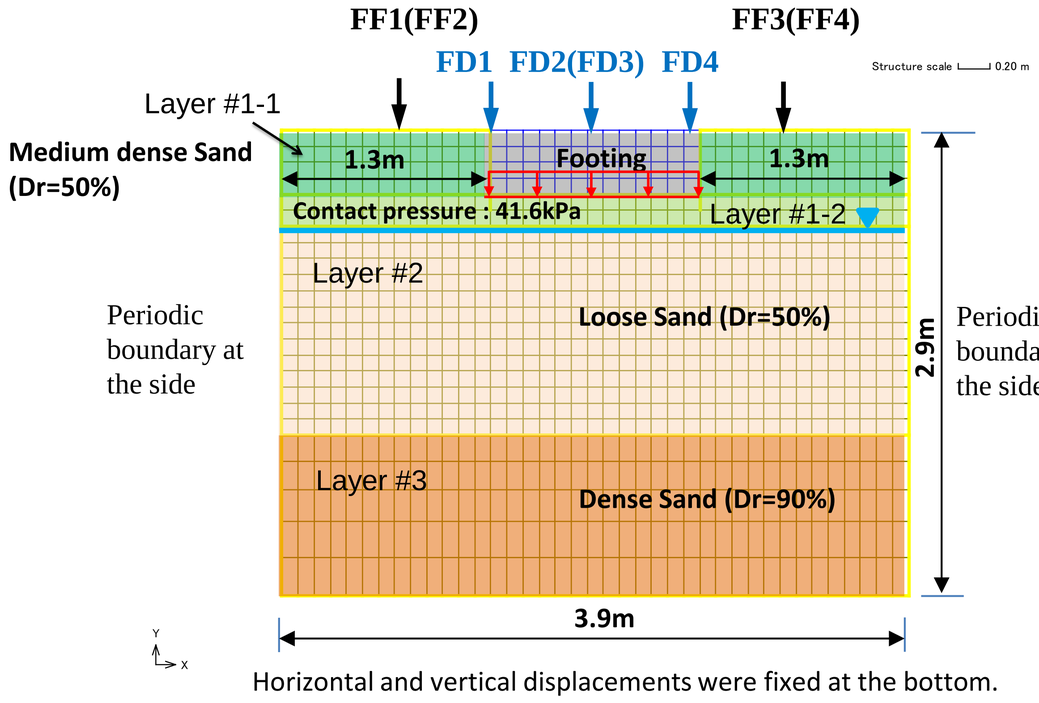

Figure 1. Two dimensional finite element model

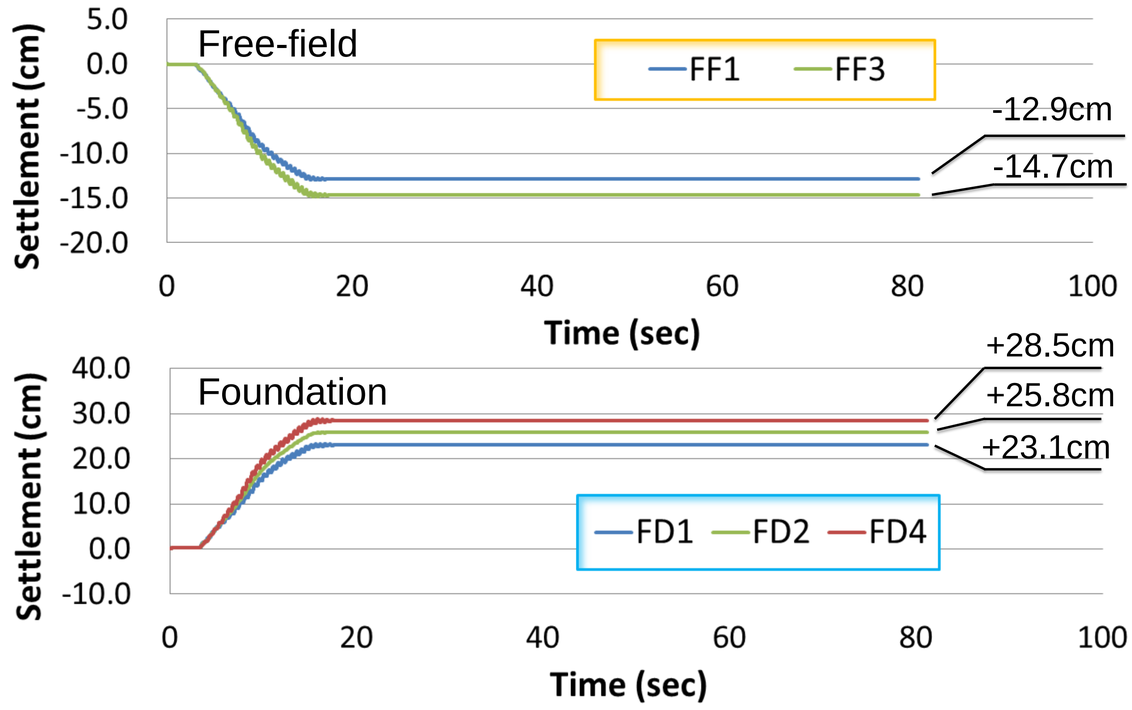

Figure 3. Time histories of settlement at free-field and foundation.

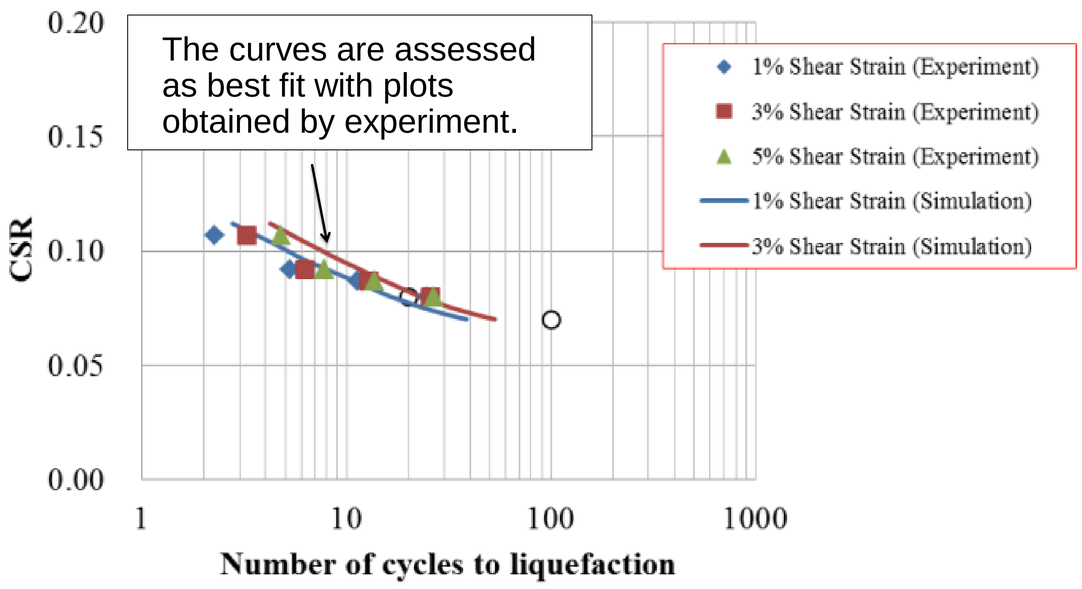

Figure 2. Reproduced liquefaction resistance curves

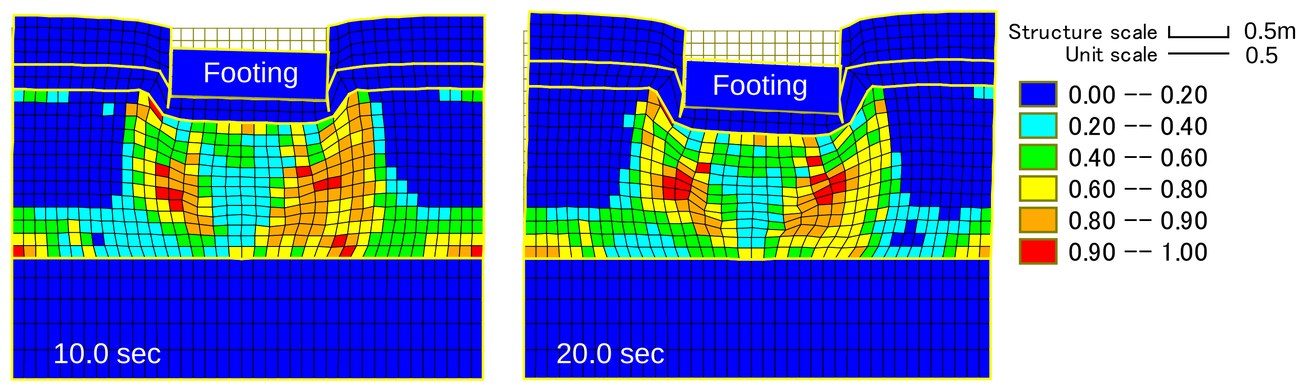

Figure 4. Distribution of ratio of excess pore water pressure.

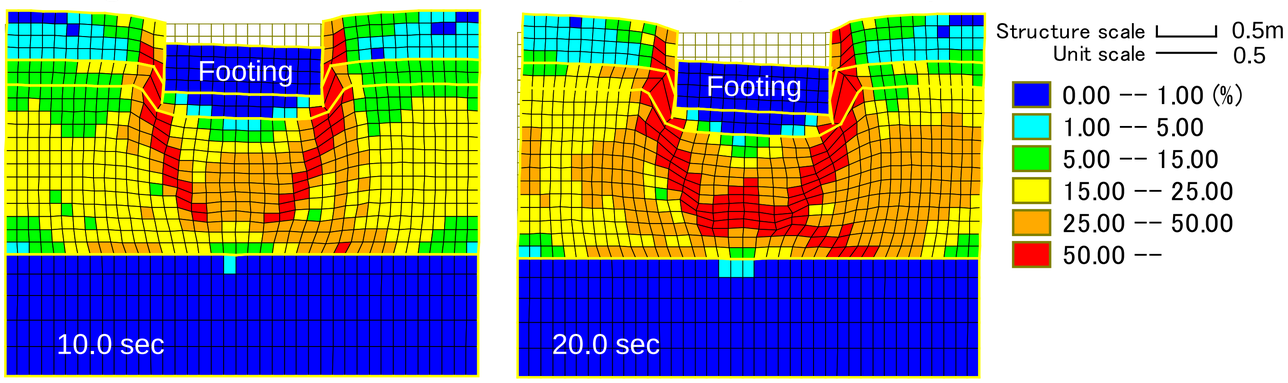

Figure 5. Distribution of maximum shear strain (γ_{max}).

Table 2. Model parameters for liquefaction

Layer	S_1	w_1	p_1	p_2	c_1
#2	0.005	0.52	0.50	0.90	1.37

Layer	*Residual strength* S_{us} *(kPa)*
#2	10.0

Conclusion:

1. Amount of settlement at the foundation continued to increase during excitation and almost ceased after shaking.
2. Permanent settlement value was predicted about 20 to 30cm at the foundation, -10 to -15cm (upward) at the free-field ground surface.

Literature cited: Ana Maria Parra Bastidas (2016), "Ottawa F-65 Sand Characterization," PhD Dissertation, University of California Davis.
Ishihara K. (1996). “Soil Behavior in Earthquake Geotechnics ”, Oxford science publications, pp.89.

Table 1. Model parameters for physical and dynamic deformation characteristics of soils.

Layer	H (m)	e Void ratio	ρ (t/m^3)	V_s (m/s)	G_{ma} (kPa)	$-\sigma_{ma}$’ (kPa)	ϕ_f (deg)	h_{max}	ϕ_p (deg)	Cyc.Str.Ratio DA=5.0%, N=20
#1-1	0.40	0.672	1.99	96	18500	3.9	30.0	0.24	—	—
#1-2	0.20	0.672	1.99	96	18500	3.9	30.0	0.24	—	—
#2 (Dr=50%)	1.30	0.672	1.99	122	29800	10.0	30.0	0.24	21.5	0.08
#3 (Dr=90%)	1.00	0.549	2.07	152	47800	16.2	30.0	0.24	—	—

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