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DISCUSSIONS

NON-LINEAR SOIL MODEL WITH VARIOUS STRAIN LEVELS AND ITS APPLICATION TO AXISYMMETRIC EXCAVATION PROBLEM[i]

Discussion by XU CHANGJIE[ii]

An applicable and easily available non-linear soil model are presented by the authors, and it agrees well with the laboratory measurement. The job is very creative and of practical value. But seen from the paper, it seems that there are still some little errors or something to be verified furthermore.

1. The authors are sure that "By smoothing the relation between E_{sec} and ε_α in region (I) and (II), the function $Y=\gamma(X)$, $Y/X=E_{sec}/E_{tan}=\gamma(X)/X$ in Fig. 7(e) can be differentiated at any point, the conclusion is suspectable. Of course, the function of Y and Y/X is continuous since smoothing function is adopted, but from the mathematical viewpoint, even though a function is continuous, which can't assure that it can be differentiated. So, only if the authors can prove that Y and Y/X can be differentiated at two "smoothing" points (corresponding horizontal coordinates are $\varepsilon_\alpha+d$ and $\varepsilon_\alpha+d$, ε_α is log scale of strain when $Y/X=1.0$), the conclusion can be drawn.

2. About the presented model, the author provides the method to decide three parameters, A, B and C, but the smoothing parameter d is very important, too. The shape of the curve of the model is decided by the smoothing parameter d to a great extent (*see* Fig. 7(e)). If the authors can provide a method to decide d, the model will be more attractive.

Above viewpoints maybe still have some mistakes, any advice from the authors is highly appreciated.

DISPLACEMENT OF STRUCTURES ADJACENT TO CANTILEVER SHEET PILE WALLS[i]

Discussion by SARAH SPRINGMAN[ii]

The authors have used small-scale model tests and middle-scale finite element analyses to deliver data relating the geometry of shallow foundations behind sheet pile walls to displacements caused by excavation in front of the walls and loading of the footing. They propose that these graphs of vertical and horizontal displacements 'may be of significant value for a preliminary assessment' for such design cases pertaining to full-scale prototypes, based on the agreement between the physical and numerical models. This contribution will attempt to explain why use of such data is likely to be on the unconservative side of reality and therefore that great care should be taken if the results are extrapolated to full-scale.

There are several important factors that invalidate the use of small-scale models, which have been constructed in sand and tested at 1 g, for *accurate* determination of deformation behaviour. These include the strongly non-linear dependency of stiffness upon stress level, the highly exaggerated influence of dilatancy at the low stresses present in a small-scale model, and side friction on the model container walls.

Stress level and dilatancy

The difference between small and full scale models can be appreciated when reviewing the equations proposed by Bolton (1986) to estimate how the peak shear stresses mobilised in a deformation controlled shear test may exceed a large strain or critical state shear stress. He normalised these shear stresses with the effective vertical stress and took the arctangent to deliver values of an equivalent internal angle of shearing resistance, such as ϕ'_{max} for the peak case and ϕ'_{crit} for the critical case. The dilatancy ψ measured along the shear plane, which describes the relationship between volumetric and shear strain, is a $f(\phi'_{max}-\phi'_{crit})$ and may be thought of (e.g. Taylor, 1948) as the additional strength due to interlocking of the soil particles. This is therefore controlled by relative density D_r.

Another significant influence is the mean effective stress level p'. For particular assemblies under increasing shear and normal stresses, the contacts between granular particles are able to slip, abbrade and shear off, essentially both a precursor to more extensive crushing at even higher stresses. Indeed McDowell and Bolton (1998) later showed that grain strength could be described by the Weibull statistics of the fracture of brittle ceramics. They further supposed that grain strength governs the strength and dilatancy of crushable soils whereby 'clastic' fracture of the smallest particles commences even at fairly low compressive stresses, tending towards a 'limited' fractal

[i] By Satoshi Goto, John B. Burland and Fumio Tatsuoka, Vol. 39, No. 4, August, 1999, pp. 111–119.
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[i] By M. Georgiadis and C. Anagnostopoulos, Vol. 39, No. 2, April 1999, pp. 99–104.
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