Column Vermeer

In the previous bulletin Kenneth E. Tand published on the behaviour of cemented sands, giving data on the initial Young's modulus E_i (or E_0) as obtained from triaxial stress strain curves. In fact this initial modulus is often used in the USA and we have also considered the idea of using it as an input parameter for the Hard Soil model. Finally we decided not to do so, because E_i is very sensitive with regard to testing techniques used in the lab. Conventional triaxial equipment tends to give relatively low values, whereas special measurement techniques will produce extremely high values. Therefore the literature gives an extremely large range of values for E_i. Hence taking E_i values from the literature has to be done with some care. To avoid any possible confusion we have chosen to use E_{50}.

As all soil stiffnesses are stress-level dependent, the true input parameter for the HS model is normalised for a confining pressure of one bar and it is denoted as E_{50}^{ref}. An intensive literature survey by Schanz (1997) indicates for remoulded quarz sands:

$$E_{50}^{ref} = 15 \text{ to } 75 \text{ MPa}$$

where the lower values tend to be found for very loose silty sands and the higher values for very dense gravelly sands. Schanz's study on the stiffness of remoulded quartz sands is especially interesting as it shows that E_{50}^{ref} is correlated to E_{oed}^{ref}, i.e. the stiffness modulus for one-dimensional compression. Hence, if one has data on the oedometer modulus, it can be used to estimate the triaxial modulus.

(two slides from the Hvar 2002 conference)

M_{DMT} very similar to "operative moduli" recommended by textbooks

p. 567 Found. Engng Handbook Winterkorn

TYPE OF SOIL	E (Kg/cm²)
Very soft clay	3.5-30
Soft clay	20-50
Medium clay	40-80
Hard clay	70-180
Sandy clay	300-400
Silty sand	70-200
Loose sand	100-250
Dense sand	500-800
Dense sand & gravel	1000-2000

(E ≈ 0.8 M

Oglio loose sand 100 b

M_{DMT}

Nile Dense sand 1000 b

- **Agreement with Moduli by Manuals important.**
- ***Normalized* case-histories. Moduli that, input in theory elasticity ⇒ reasonable Settlements. Predicted *well* for decades real settlem. real cases.**
- **∴ M_{DMT} usable for simplified analysis in every day jobs (or big jobs in parallel FEM).**

PLAXIS INPUT PARAMETER ("HARD SOIL MODEL")

Recommended basic input : E50,ref (Trx modulus confined at 1 bar).

Extensive Research Schanz (97) : for many quartz sands range of E50,ref = 15-75 MPa (input param. for HS Plaxis)

-Prev. Table *sand* moduli :

Silty sand	**7-20**
Loose sand	**10-25**
Dense sand	**50-80**

ranges remarkably similar

Since M_{DMT} ≈ Table, M_{DMT} might be of help when selecting input parameter for Plaxis HS.

Summary

The recommended basic input for Plaxis Hard soil model is E_{50}^{ref} (Trx modulus confined at 1 bar).

Schanz found for quarz sand E_{50}^{ref} =15 to 75 MPa (loose to very dense sand). He also found E_{50}^{ref} correlated to E_{oed}^{ref}.

In sand the range of M_{DMT} by DMT is remarkably similar to above range (15-75 MPa). Hence as a 1st approximation may assume $E_{50}^{ref} \approx M_{DMT}$