Geotechnical uncertainty - Estimation of soil parameters

by Dr. C. Sachpazis

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How to minimize geotechnical uncertainty and improving geotechnical property estimation, when you don't have all the data

How to minimize geotechnical uncertainty and determine soil parameters when you don't have all the data.

Geotechnical uncertainty is a major issue in deep excavation and geotechnical design. Minimizing uncertainty and estimating design soil property presents a major challenge to engineers. Most projects have only SPT test data, and different methods can result in widely varying strength estimates. Reviewers often ask for justification of estimated soil strength parameters, so how does one meet these challenges?

In certain softwares, like DeepEX 2020, we addressed this major challenge by offering a solid framework for estimating soil parameters from well accepted correlations, from SPT, CPT, index properties, and other tests. We can then compare soil property variability with depth, in plan-view, and make informed decisions. Then design soil properties can be determined based on a statistical analysis by setting the desired lower bound values.

While there is no substitute for good laboratory and insitu strengths, very often such data is simply missing or the client is not willing to pay for it. The following figures demonstrate how we have met these challenges to offer you a solution that has your back, fully referenced, with equations, and graphs. The solution steps are:

1) Define your borehole layers and major soil types based on available geotechnical investigations

2) Define available test data, such as SPT, CPT, Plasticity Index tests, etc.

3) Select and investigate established correlations

4) Review parameter variabilty with different equations, depth, or in plan

5) Review parameter variability vs. the database recommendations

6) Select lower bound level values, typically at 5% to 25%. For example, a 5% lower bound design value represents that only 5% of the soil estimated parameters are smaller than the design level.

7) Include report with full equation references in your calculations

We are not stopping there, a new geotechnical database service by Deep Excavation will be available early in 2020. This interconnected online database will allow you to reference and import actual soil profiles and select based on a range of parameters.

This is the way forward for geotechnical engineering, this is the way forward for deep excavation design.

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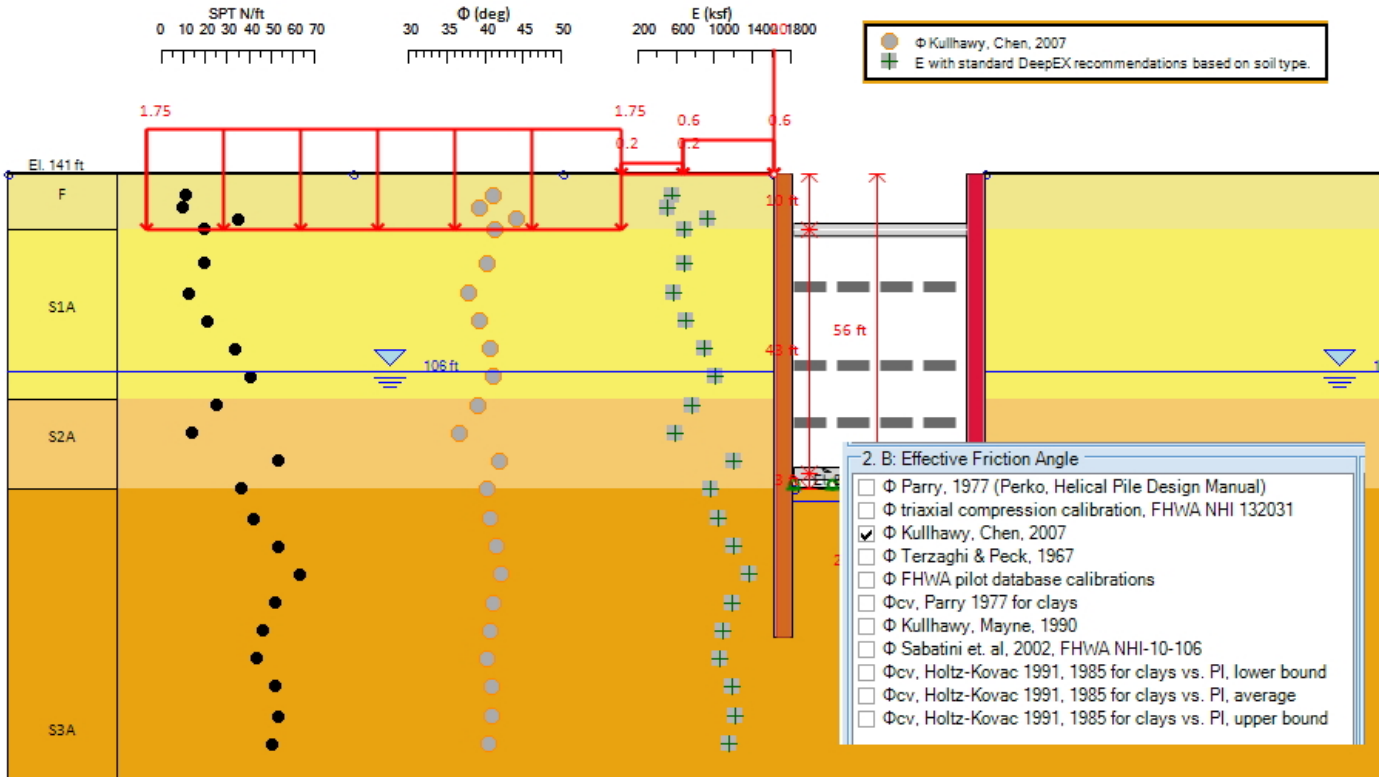

Figure 1: SPT test data vs. estimated friction angle and elasticity modulus

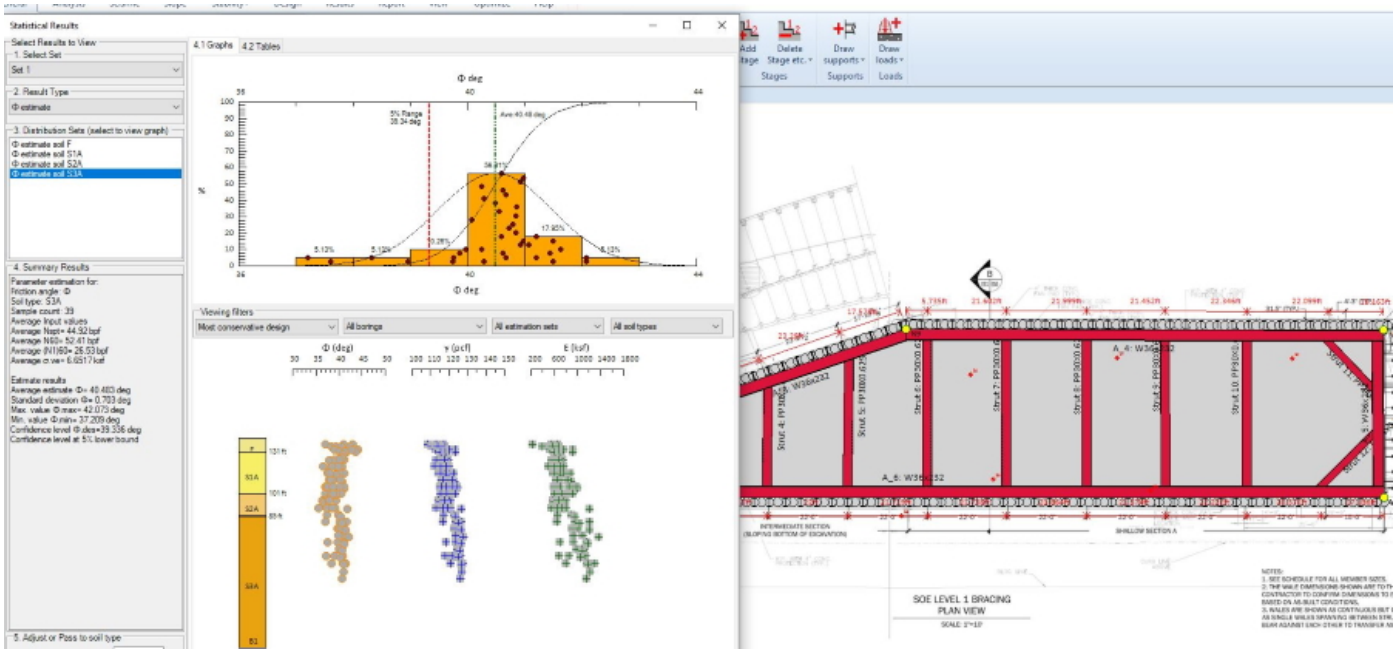

Figure 2: Statistical property estimation from a number of available boreholes and SPT test data

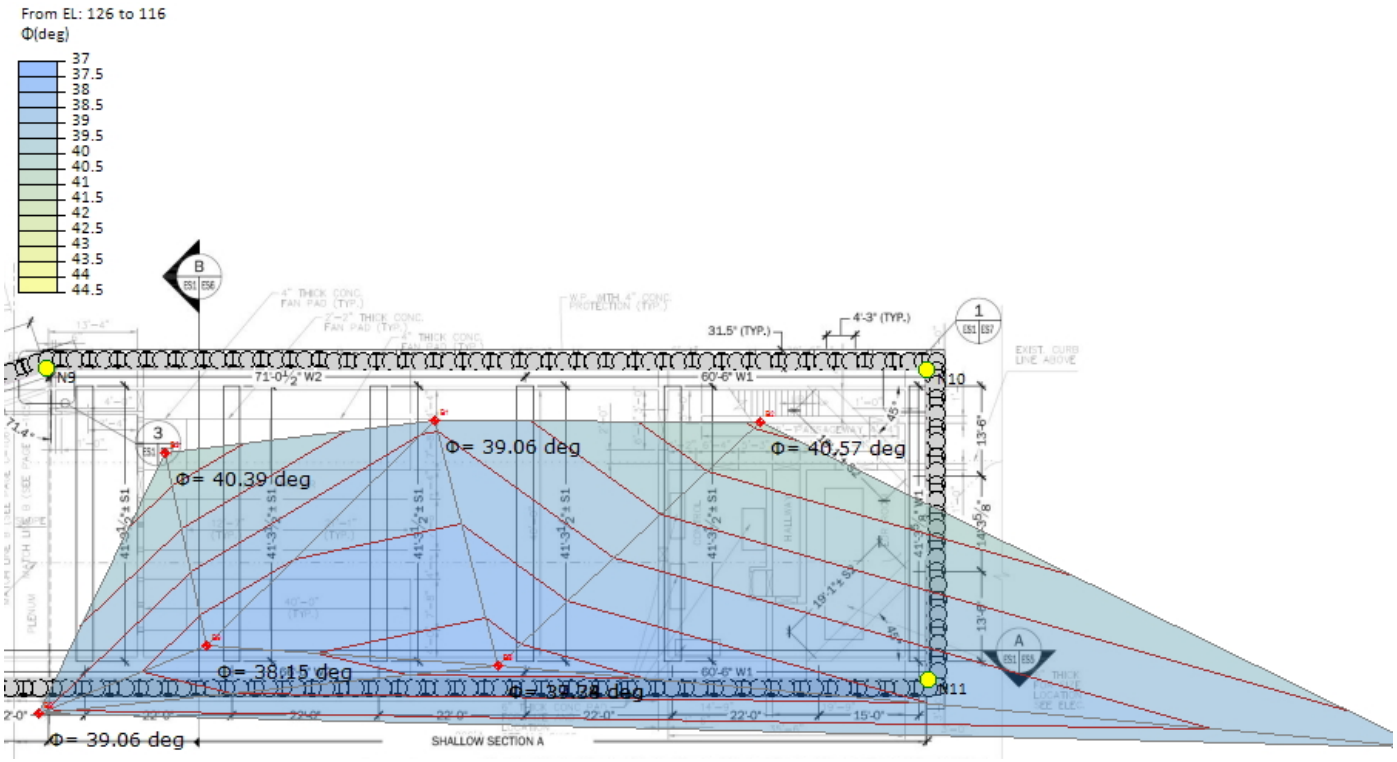

Figure 3: Contours of estimated friction angle within a specified elevation zone

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As geotechnical engineers, we typically encounter two general groups of uncertainty:

(1) what we know we don't know (identifiable uncertainity), and
(2) what we don't know we don't know (conceptual uncertainty).

As the professional practisitor we deal mostly with geometries and materials that nature provides. These natural conditions are unknown to the designer and must be inferred from limited and costly observations. The principal uncertainties have to do with the accuracy and completeness with which subsurface conditions are known and with the resistances that the materials will be able to mobilise. The uncertainties in structural and mechanical engineering are largely deductive: starting from reasonably well known conditions, models are employed to deduce the behaviour of a reasonably well-specified universe. But, uncertainties in geotechnical engineering are different and we must employ our best efforts to infer the behaviour of often a poorly-defined project site. Consequently, another common way at looking at geotechnical uncertainty is also in two groups:
(1) Due to geological or natural constraints, and
(2) Due to social or human nature.

From the two groups, one can broadly identify seven types of geotechnical uncertainty affecting performance..

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