Understanding Your Geotechnical Engineer or Getting Your Geotechnical Engineer to Understand You

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This article aims at demystifying the culture of geotechnical engineering in order to improve the dialog and state of the practice between geotechnical and structural engineers. It has been the experience of the authors that there is something of a communication disconnect between the two camps, and that geotechnical engineering has grown up with its own unique way of doing things that may have alienated it somewhat from the larger civil engineering world. To some extent, this has provided geotechnical engineering with an aura of authority that at times tends to resist rational application of engineering concepts, something that is wholly foreign to most structural engineers. If geotechnical engineering can be presented to structural engineers in their language, the authors believe that it will facilitate greater economy in structural design.

The idea for this article came about due to close collaboration between the authors in delivering training programs to their employer's workforce for implementation of the Load and Resistance Factor Design (LRFD) methodology specified by the American Association of State Highway and Transportation Officials' (AASHTO) *LRFD Bridge Design Specifications*. The authors' drive to deconstruct barriers of existing professional worldviews between geotechnical and structural engineers has led to synergistic results in the teaching, learning, and working methods evolving in implementation of this new design code.

What's In a Name?

One of the stumbling blocks between structural engineers and geotechnical engineers is that it seems the former deal more closely with engineering concepts, whereas the latter have a penchant for specifying methods by name. Specifying a method of test or analysis by name is a nice way to recognize someone, but it also fosters a breach of understanding between, in this case, the structural and geotechnical engineers.

Structural engineers seem to have only a handful of name-specific parameters or methods in their toolbox, and most of these are equally-well known by their generic names or concepts. Examples include Young's Modulus (elastic modulus), Hooke's Law (linear stress-strain relationship), Euler buckling (column buckling), Whitney Stress Block (rectangular stress block), Hardy Cross Method (moment distribution).

Geotechnical engineers seem to employ a much more extensive name-specific tool box, and any generic name or underlying concept is seldom discussed. Examples include Rankine and Coulomb earth pressure theories, Terzaghi bearing capacity factors, Meyerhof Method of bearing capacity, Nordlund Method for pile capacity, Atterberg Limits, and Proctor Density Tests (Standard and Modified). For example, for all the apparent confusion over the difference between the Rankine and Coulomb theories, the only practical difference is that the latter accounts for the friction against the back face of the wall; the upshot is that Coulomb theory produces lower driving (active) pressures and significantly higher resisting (passive) pressures. Any initial explanation by a geotechnical engineer beyond that is getting way off base. Structural engineers should be able to receive a rational explanation of any name-specific method from a geotechnical engineer. Most of the explanations will reduce to simple discussions of the application of statics or strength of materials, such as assumptions on the treatment of friction.

It is reasonable for a structural engineer to expect the geotechnical engineer to converse in the language of engineering mechanics. For example, one of the tasks that geotechnical engineers are often hired by structural engineers to perform is the analysis of piles or shafts for lateral deflection. The specialized programs that the geotechnical engineer will use might actually be better understood by a structural engineer, as the basis of the programs centers on essentially the same equation about which so much of structural engineering revolves, $dy^2/dx^2 = M/EI$. A geotechnical engineer ready to explain results, when necessary, with this concept in mind will be much better able to communicate with structural engineers. In fact, should structural engineers wish to try out such a program for themselves, the only difficulty initially faced would be which values to input for the soil parameters. But as discussed next, these values are often simply selected or estimated by geotechnical engineers from commonly-used index tables or charts. One of the most important considerations for which to watch out, as always, is the groundwater table.

Standardized Values

Another point of confusion between the geotechnical field and structural engineers probably stems from geotechnical engineering having grown up without a unified code. Many commonly used tables or charts of soil parameters reference someone's name and are found in specific textbooks or manuals. Unfortunately, there really is nothing in geotechnical engineering similar in authority or universality to documents like the AISC *Manual of Steel Construction* or the ACI *Building Code Requirements for Structural Concrete*.

The geotechnical profession often responds that a lack of standardization of values for soil parameters is due directly to the fact that soil is not homogeneous. As a result, standardized values for strength, density, cohesion, etc., cannot be used. In practice, however, perhaps more often than not, de facto standardized values from widely recognized textbooks or manuals are used for design. In the interest of fostering better working relationships between structural and geotechnical engineers, the authors urge structural engineers to question to their satisfaction the data, methods, and results presented by geotechnical engineers. The authors urge geotechnical engineers to be forthcoming and open with their data and calculations. The obvious way to deal with non-homogeneity of soils is with a documented, reviewable, and rational statistical and probabilistic analysis of the geotechnical data; this is an area where the value of experience could really show itself in a geotechnical engineer.

Structural engineers should be provided with the data and the source or method of soil parameter estimation based on that data. There is nothing wrong with using standard values based on limited data. A tricky question often arises when more geotechnical exploration or testing is proposed. The qualitative purpose of the further expense should certainly be laid out by the geotechnical engineer, and in fact a quantitative assessment could be proposed as well. This assessment could be based on confidence limits of probabilistic inference and statistical evaluation by the geotechnical engineer, based on experience. Again, the value of engineering experience with soils really must be made to count in a rational way. It should also be pointed out that every geotechnical report would preferably include a purpose and a rationale for the data being collected.

Lastly, regarding codified values, the AASHTO *LRFD Bridge Design Specifications* does include a comprehensive collection of geotechnical information. For lack of a better starting point for codified information, this is one ready reference. It should be noted the AASHTO code is often cited as being more conservative than codes ordinarily used in private-sector practice, but this fact is not so relevant for the given tables of parametric soil data.

Conclusion

We hope to have furthered progress in tackling thorny issues related to geotechnical engineering. Keep the dialog going and insist on rational methods of handling geotechnical data! Subsurface engineering experience must be made to count in a quantitative manner. Let the quality revolution continue in our hands and in our practice.▪

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