

Facilitating Input Data Breakthroughs in Geotechnical Engineering

In geotechnical engineering today, numerical modelling capabilities exceed our understanding of soil and rock mass behaviour and the ability to measure input properties. This article will discuss a belief that the creation of a database of properties will accelerate progress towards better quantification and understanding of material behaviour.

Introduction

The maxim “garbage in garbage out” is used so often that it may have lost some of its significance. Yet it remains so true of modelling in general, and of geotechnical modelling in particular. Two enduring and challenging problems in practical geotechnical engineering have been the lack of data and incomplete understanding of the constitutive behaviours of soils and rocks.

Dr. Evert Hoek lamented the lack of research into the prediction of rockmass strength and deformation properties in a 1994 *Letter to the Editor of the ISRM News Journal*. He wrote, “...while the problems are understandable, we have to ask what we are doing to try to improve our understanding of these problems? The answer is very little.” He ended his letter with these words, “It is my hope that this short note may catch the eye of someone who has

the skill and the motivation to pick up the challenge and to lead in the development of better tools for providing us with the input data which we need for rock engineering designs of the future.”

Ten years later the situation has not changed much. Although we are able to solve a great variety of geotechnical problems using today’s computers and numerical methods, in general our ability to compute and analyze far outstrips our ability to understand material behaviour and measure geotechnical properties. Many geotechnical experts agree on this state of affairs. Barring major breakthroughs, improved understanding of material behaviour and accurate techniques for the collection of data will remain challenges in the foreseeable future.

Accelerating the Discovery Process

We believe that geotechnical engineering can accelerate progress through more efficient use of existing knowledge and technology. Presently, we do not store data on soil and rock mass properties collected during project investigations efficiently. On any single project the volume of material sampled is very small compared to the volume of soil or rock mass influencing behaviour. However, in several jurisdictions around the world, the cumulative amount of information on the mechanical properties of soils and rocks collected each year is not insignificant.

The problem is that this information is not easily available, even within a geotechnical firm. With passing years more and more data that could be invaluable to our quest for better understanding and characterization of material behaviour is lost – although the information may be in reports sitting on shelves, it is not readily retrievable. Nothing can be built upon information that is not there.

A Database of Geotechnical Properties

A few years ago, the Rock Engineering Group at the University of Toronto saw a need to create a central repository of geotechnical properties from around the world and embarked on a project to do so.

In the first phase of the project the research team developed a web-based relational database, which included only rock properties that had been published in various books and technical papers. After the initial funding was done, Rocscience took over the project, overhauled the program's interface and included more rock properties in the database. The refined database was named *RocProp*.

Most recently the company has developed a stand-alone version of *RocProp*. The new program can calculate statistics such as mean, standard deviation and the distribution of any set of property values retrieved in a search. *RocProp* also provides charting tools that enhance data interpretation.

To expand the database and its utility, both the university and the company appealed to geotechnical and mining companies for reliable information on geotechnical properties. Unfortunately, companies are yet to answer to this call. One of the major reasons why companies have not responded is because they cannot easily supply the data. To do so, they would have to designate personnel to manually comb through reports or spreadsheets for the relevant data. The process is manual, tedious, prone to error, and costly to the companies – somebody has to pay for the time spent.

Since the initiative holds great promise for geotechnical engineering, a new strategy, outlined next, has been drawn up and is being implemented.

New Strategy: RocData 4.0

We believe that firms will be more motivated to efficiently store their soil and rock properties in electronic databases once they have tools, which enable them to easily do so, and once they experience the benefits to be derived from straightforward and flexible retrieval, sharing, analysis and export of such data. With the existence of such data records, it will be much easier for companies and institutions to share information and contribute properties to a central repository. Also, having experienced the benefits and realized the potential of a database, geotechnical companies will have greater justification for allocating resources to the electronic storage of geotechnical data.

To initiate the outlined vision, a stand-alone version of *RocProp* has been incorporated into the latest version of *RocData 4.0*. *RocData 4.0* is a program for determining strength parameters of soils and rock masses from test (laboratory or field) data, or estimating these parameters. It has built-in tables of typical parameter values

and, for some strength criteria, charts and tables for estimating strength parameters. *RocData* can also estimate the modulus of elasticity of rock masses from Generalized Hoek-Brown parameters. It facilitates the study of strength behaviour by rapidly responding to user inputs and instantly plotting strength curves. Being a stand-alone program, it allows firms to access data without the need for network or internet connections.

Benefits

RocData 4.0 provides advantages similar to those of relational databases. It allows easy and rapid access to verified, reliable data. This data can be queried and retrieved in a variety of ways. Existing records can be easily modified and new data types and records can be readily added. The program also supplies graphing and statistical tools for interpreting data.

Combined with the strengths of the previous version of *RocData*, the new program can help geotechnical engineers maximize the amount of information gleaned from data on soil and rock properties. As a company enters more data into the program, the wealth of stored information becomes evident during the feasibility stages of projects, when reliable first estimates of geotechnical properties minimize the costs of design revisions.

Using *RocData* 4.0, newly acquired properties can be compared to previous measurements and measurements from other places. We also believe that by being able to present the range over which a property varies, *RocData* will foster a proactive approach to design. It will help geotechnical engineers to anticipate risks and identify project aspects that require careful monitoring.

Future Directions for RocData

To enable geotechnical engineering to increase the insights that can be gained from sampled data on sub-surface conditions, we intend to add geostatistical analysis capabilities to *RocData* in the future. Such a feature would allow engineers to visualize alternative interpretations of site conditions, and help determine the conditions that are more likely to prevail.

We also intend to include features that allow automatic export of geotechnical properties and statistical information to programs such as *Phase²* and *Slide*, which are used to design or analyze geotechnical structures and excavations. This would facilitate investigation of the impact different values of input parameters would have on a design, helping us to access the risks of failure or unsatisfactory performance.

Final Remarks

We believe that if geotechnical engineers could readily retrieve existing geotechnical information from different parts of the world, they could develop better designs and strategies during the feasibility phases of projects. They could design better site investigations, and better allocate data collection resources.

We also think that the existence of a database of geotechnical properties would accelerate the discovery of constitutive laws that better describe soil and rock mass behaviours. It can help us to arrive at the point where our understanding of soil and rock mass behaviour, and our ability to measure input properties, match the capabilities of our numerical models. But we must remember that the speed of success will depend on willingness to contribute data to the repository.

We encourage readers to send in comments and views on this topic to RocNews Feedback. We hope that a vigorous and free-flowing discussion will stimulate some breakthrough ideas in other readers.