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Guest Editorial

Data Scatter – Some Submissions!

Over three decades ago, ever since I started working in the area of Rock Engineering – particularly in the laboratory – the uniqueness of the discipline of Rock Engineering, on account of rock being a naturally occurring material, formed as a consequence of geological processes spread over mind boggling geological time scale, has always fascinated me. Because of my interest in the humanity per se, consciously and subconsciously, I have always compared and contrasted rock with human being. Like one cannot straitjacket human beings – despite grouping(s) on the basis of several different criteria – similar is the case with the rock, I feel.

The same geological nomenclature for two different rock masses notwithstanding, many times, one finds huge variability in the test data of different properties and parameters. Even for a given rock mass, or the rock cores from a given project site, the two sub-variants, or even the same variant has huge variability or scatter in the test data. How does one deal with this scenario?

In addition to the above, there is no one-to-one correspondence, even a qualitative one, between different properties and parameters of any two rocks. That is, say, for a given rock type, one variant with respect to another drawn from another place can be inferior in respect of one property and/ or parameter, but the case may be reverse in respect of another property and/ or parameter!

Given the above backdrop, here, I wish to briefly discuss the issue of the database. One, quite often, the database is not commensurate with the scatter in the said property or parameter. Two, the database is inadequate for statistical treatment on two counts – one, in itself, the database being very small for application of any statistical treatment; two, on top of it, more often than not, the scatter being appreciable, the applicability of statistical treatment demands a database that is larger than normal!

I wish to make following submissions in this regard – and I hope that the suggested multi-pronged approach would help make us some progress in dealing with the challenge of scatter in the test data.

1. The rock needs to be investigated at all levels – micro-level; laboratory-scale; and in-situ.

Micro-level: For micro-level studies, analysis is undertaken, employing i) petrographic technique, ii) SEM (Scanning Electron Microscope), and iii) XRD (X-ray Diffraction) method. The chemical composition and structural arrangement at the micro level, both, are invaluable information in understanding the failure pattern and the scatter in the test data.

Laboratory-scale: The physical properties and engineering parameters, evaluated in the laboratory, are crucial inputs for numerical modelling. More often than not, the variability in the test data is most pronounced in case of engineering parameters. And, it is this that needs to be addressed in two different ways. One, through evaluation of rock at all the three levels. And, two, through evaluation of large number of samples – commensurate with the scatter in the test data for any parameter!
In-situ: The value of the twin advantage of in-situ assessment – that is, the presence of the in-situ stress and the assessment under real-life conditions – cannot be over stated. However, even for the selection of site(s) for the in-situ assessment, the role of the micro-level and laboratory-scale studies is crucial and need not be elaborated here.

I would like to explain and/ or support my emphasise on the number of investigated samples to be commensurate with the scatter in the corresponding test data of an engineering parameter, through the ‘first’ published literature on the laboratory assessment of shear strength parameters of granite gneiss, dealing with ‘unusual’ scatter – even when the samples were drawn from the same drillhole and/ or drillholes in close vicinity to each other. The extremely ‘erratic’ data – not even reflecting increasing ‘axial stress at failure’ with increasing ‘confining pressure’ for the mandatory minimum 5, or even 9, samples – could be satisfactorily understood and explained only after around 50 samples were investigated!

That was so, because the 50-odd samples were required to subsume the inherent variability of the high-strength granite gneiss and throw up the natural response of overall increasing ‘axial stress at failure’ with increasing ‘confining pressure’, in a sort of band-of-scatter that could be enclosed within ‘lower-bound’ and ‘upper-bound’ envelops!

Foregoing is an illustration of the supporting ‘live case’ that underlines the need for the number of the samples to be tested for an engineering parameter in the laboratory to be commensurate with the scatter in the corresponding test data.

I am unable to resist the temptation of recounting an anecdote involving Prof. Kalman Kovari, who, after a highly enlightening lecture at Central Soil & Materials Research Station, New Delhi, had said: ‘I quote you, and you quote me; and, because I am from Switzerland, and you are Indians, we all would become international experts. However, the poor tunnel would collapse as it would not know that it has to stand according to our theory!’

To conclude, there is no alternative to adequate comprehensive investigations – as dictated by the specific real-life situation – if one wishes to do justice and understand the rock holistically; else, the purely technical objective, even if ‘achieved’ on the basis of ‘assumptions’, is doomed to failure in the long run, because the Nature deserves utmost respect from her most intelligent species, the human being. After all, the all-encompassing Nature has her own laws, secret preferences, and diverse ways to reprimand and chastise her erring children!

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