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Editorial

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This is the second of two issues in a themed collection of papers in *Engineering Sustainability* on the topic of sustainability and resilience in geotechnical engineering. This issue of *Engineering Sustainability* comprises five papers; four papers on the theme were in the February issue (Keaton, 2018a). All nine papers were published 'ahead of print' on the ICE Virtual Library homepage of *Engineering Sustainability*, thereby allowing quicker access to fresh content.

Improved awareness among geotechnical engineers of opportunities for balance among the three pillars of sustainability – economy, environment, and equity – will help transform good engineering into better engineering on all projects, mundane to magnificent. Sustainable solutions should no longer be dismissed as just 'good engineering'. What we call 'sustainable engineering' today is more than just good engineering, but it is less than what good engineering will become in future decades.

The first paper in the April 2018 issue of *Engineering Sustainability* reviews life-cycle-based environmental assessments of geotechnical systems, recognising that geotechnical engineering applications of life-cycle analyses (LCAs) are lacking because of barriers related to availability of region-specific data, spatial heterogeneity of soil profiles, and design alternatives, among others (Kendall *et al.*, 2018). Sufficient life-cycle-based analyses have been published on a variety of geotechnical systems to provide a basis for this critical review. The goal of this paper is to (*a*) determine the state of practice of LCAs in geotechnical engineering, (*b*) identify the most critical parameters and widest gaps, (*c*) describe sources of variability and (*d*) recommend best practices for future LCAs leading to development of standardisation with common guidelines. This 11-page paper describes many interesting findings, such as (*i*) the majority of published LCAs considered the geotechnical application life cycle to end at the completion of construction and (*ii*) performance characteristics tended to be restricted to geotechnical parameters that limit the ability to compare alternative methods (e.g., ground improvement of a designated volume of soil to a normalised standard penetration test blow count that may not be a useful index for deep soil mixing).

The second paper focuses on urban underground utility infrastructure projects, recognising the critical functionality they have in urban environments where most utilities are under city streets (Hojjati *et al.*, 2018). Installing new and maintaining and upgrading existing urban underground utilities, collectively called streetworks operations, is highly disruptive to communities. The direct cost of construction (including damage to adjacent utilities and property) was less than the estimated indirect cost of societal and environmental impacts. This paper recognises that traditional open-cut methods are becoming unsustainable because of the societal costs, as well as economic and environmental factors, which necessitates alternative methods, such as trenchless technologies and multi-utility tunnels. Hojjati *et al.* (2018) realise that a barrier to implementation of these alternative methods is a compelling business case for their routine use based on evidence of their value compared to implementation cost, which is the subject of this 13-page paper.

The third paper uses the upgrade and improvement programme of the existing railway between Edinburgh and Glasgow, in Scotland, to demonstrate the value of foundation reuse for bridges and platform extensions that will be required for higher capacity delivered by longer trains, as well as electrification of the system (Neves *et al.*, 2018). The health benefits of rail electrification have been recognised for a long time; reuse of existing foundations is desirable from a sustainability perspective in reducing costs of construction, financially as well as in terms of environmental factors associated with demolition of existing foundation elements and time, materials and installation costs of new foundation systems. Additional geotechnical sustainability benefits described in this nine-page paper were realised with bridge abutments and tunnels, as well as two-track-slab systems with sleeper supports embedded in concrete in lieu of ballasted track. The track-slab systems allow faster trains to operate with enhanced efficiency and passenger comfort because of reduced vibration. Prefabricated track slabs and bridge deck beams reduced construction duration with resulting efficiency benefits, including minimising disruption to local communities.

The fourth paper presents an analysis-based framework that incorporates both sustainable and resilient engineering designs and solutions to assess infrastructure (Bheemasetti *et al.*, 2018), using as an example a geotechnical-stability investigation of an 88-year-old water-supply levee system. This 12-page paper comments on the conventional sustainability quantification metrics of equivalent carbon dioxide emissions and embodied energy, as well as life-cycle cost analyses of alternative design and construction processes. It then describes resilience metrics as being addressed through risk- and reliability-based design, and recognises the complex challenge of balancing sustainable solutions that may not be resilient to all reasonably possible forces with resilient solutions that may not meet sustainability metrics, at least when considered for a specific infrastructure feature. Sustainability assessments considered economics of geotechnical investigation (dollars) and environmental effects of embodied energy and carbon dioxide of materials, fuel, and on-site operations. Societal benefits are not considered separately, but are linked to the speed of completing the investigation and reopening the system to recreational use. Resiliency assessments considered two-dimensional mapping (longitudinal and depth) of reliable soil strength parameters based on geostatistics

The final paper in the April 2018 issue of *Engineering Sustainability* is a retrospective of a low-volume road restoration project to identify infrastructure sustainability elements of the Envision rating system that could have been applied if the rating system had been developed a few years earlier than its 2011 publication date (Keaton, 2018b). This ten-page paper describes a project that was considered to be restoration of vehicle access, rather than road repair, because the unpaved, one-lane road with turnouts crossed a major, deep-seated landslide in a seismically active area near Los Angeles, California, that could not have been shown to have an acceptable factor of safety if the road were treated as conventional infrastructure. The road is used only by a government agency to access wildland fire facilities, but it is also used by hikers. The Envision rating system was applied retrospectively to the simple but challenging project, and applicable sustainability elements were found in all five Envision categories: (1) quality of life, (2) leadership, (3) resource allocation, (4) natural world and (5) climate and resilience.

As with the four papers in the February 2018 issue, the papers in this issue of *Engineering Sustainability* describe ‘good engineering’, while demonstrating that geotechnical engineers contribute to sustainability and community resilience. Read on, and hopefully you will be motivated to comment on some aspect of at least one of the interesting papers in this issue.

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