Editorial

Jeffrey R. Keaton PhD, PE, PG, D.GE, ENV SP, F.ASCE, F.GSA
Principal Engineering Geologist, Amec Foster Wheeler, Los Angeles, CA, USA

The first issue of *Engineering Sustainability* in 2016 contains three papers that represent engineering sustainability at three different scales – or do they? The first paper integrates and ranks sustainability criteria for housing in 28 pages and with 64 references. The second paper focuses on the gap in predicted energy use on which a university building was designed and actual energy used in the occupied building in 8 pages and with 32 references. The third paper describes two properties of paper concrete made of newsprint, water, and fly-ash based cement in 6 pages and with 22 references.

The first paper (Abdul-Rahman *et al.*, 2016) begins with the important recognition that most current building sustainability criteria are skewed toward the environment with general disregard for the economy and society, making them environmental performance criteria, rather than performance criteria for sustainability in its triple-bottom-line context. The authors note that one rating system for infrastructure includes all three factors, but no sustainability framework provides sufficient guidance for evaluating or balancing the tensions among the three competing factors. This paper determined and prioritised sustainability criteria for residential buildings using expert-based structured interviews with 25 carefully selected building practitioners and academic scholars from 16 nations.

Multi-criteria decision-making with the analytical hierarchy process was implemented, and a fuzzy weighted triquetrous sustainability model was developed. The details are presented in 31 tables with systematic treatment of environmental, societal and economic sustainability factors. Comparison matrices at the sub-criteria level are presented for the three factors, as are the details of fuzzy averaging. The research used language terms (strongly, more important) to capture the vagueness of decision-making and applied a triangular fuzzy scale (3/2, 2, 5/2) and reciprocal scale (2/5, 1/2, 2/3) to represent the fuzzy numbers. The fuzzy rule was applied for averaging experts' judgements. Defuzzification was conducted to generate crisp numbers for determining priority weights. The steps in the process are described in the paper.

The top-ranked sustainability criterion was societal (safety issues) and the two top-ranked sustainability sub-criteria were societal (design considerations toward safety and management considerations toward safety). The paper concludes with an invitation for construction practitioners to use the fuzzy-weighted triquetrous sustainability model for decision-making. Recognition is given to non-negligible rankings for all sustainability criteria and sub-criteria, but also to the impossibility of giving all criteria the same level of attention. The rankings enable available attention to be given to the top criteria to satisfy sustainability objectives.

The second paper (Robinson *et al.*, 2016) tracks energy performance in a university building to evaluate the gap created by competing priorities between occupants' needs and wants and building operators' desire for energy efficiency to attain nearly zero-energy building status. This case study devised a non-domestic energy efficiency performance (nDeep) model that identifies and quantifies the gaps between building design, building management and operation, and building occupant behavior.

A building management system is configured for the building to be occupied from 9:00 am to 6:00 pm Monday through Friday. Interviews with nearly 50% of the 180 building occupants revealed that, on average, the building is used 8 h per day for 5 d per week. However, actual use ranged from 3 to 7 d per week and 5 to 11.5 h per day, demonstrating a substantial departure from what the building management system was programmed to support. Overall the four-story building performed well in comparison to building use survey benchmarks; however, two main factors contributed to the energy use performance gap. Half of the respondents reported that the building was cold in the winter, contributing to unsatisfactory winter thermal comfort; respondents reported too much artificial and natural light. The temperature of the entire building was controlled by a single thermostat, and strip lighting throughout the building was operated by motion sensors with disregard to the level of natural light.

Energy efficiency of the building was likely to be compromised by giving priority to occupants' preferences; occupants were likely to be dissatisfied if the building was operated for efficiency. The nDeep model documented the energy performance gap between building occupants and building operators, and may lead to more realistic prediction of energy use for design of buildings in the future.

The final paper (Balaga and Nanthagopalan, 2016) begins with statements about an environmental sustainability criterion (carbon dioxide emissions by the concrete industry) and a societal sustainability criterion (paper being sent to landfills), and moves on to paper concrete; a cheap, lightweight building material with good insulation and fire resistance properties. The beneficial sustainability qualities of diverting paper from landfills and reducing greenhouse gas emissions for production of a building material are mentioned on the first and second pages of the paper, with the subsequent four pages devoted to material properties, apparently to promote use of paper concrete as a sustainable building material and by quantitatively addressing some perceived or potential limitations.

So, do the three papers in the February 2016 issue of *Engineering Sustainability* represent engineering sustainability at three different

scales? Without a doubt, the three papers represent three different scales. Are all three papers engineering sustainability? Editorial board members discussed the third paper as one that is suitable for and might belong better in *Construction Materials*. On one hand, having the ‘paper concrete’ topic published in a different journal would allow something else to be included in *Engineering Sustainability* and result in a material properties paper with sustainability content to be included in *Construction Materials*. On the other hand, having the ‘paper concrete’ topic in this journal exposes the readers to something about material properties. Is it possible that either the ‘sustainability criteria for housing’ paper or the ‘energy performance gap analysis’ paper might belong better in a different journal? I think all three topics fit well in *Engineering Sustainability*. What do you think?

REFERENCES

- Abdul-Rahman H, Wang C, Wood LC and Ebrahimi M (2016) Integrating and ranking sustainability criteria for housing. *Proceedings of the Institution of Civil Engineers – Engineering Sustainability* **169**(1): 3–30, <http://dx.doi.org/10.1680/ensu.15.00008>.
- Balaga HK and Nanthagopalan P (2016) Studies on strength and weight loss of paper concrete. *Proceedings of the Institution of Civil Engineers – Engineering Sustainability* **169**(1): 39–44, <http://dx.doi.org/10.1680/ensu.14.00057>.
- Robinson JF, Foxon TJ and Taylor PG (2016) Performance gap analysis case study of a non-domestic building. *Proceedings of the Institution of Civil Engineers – Engineering Sustainability* **169**(1): 31–38, <http://dx.doi.org/10.1680/jensu.14.00055>.