New ASCE Book Highlights Cutting-Edge Research Into Life-Cycle Concepts

BY Ben Walpole

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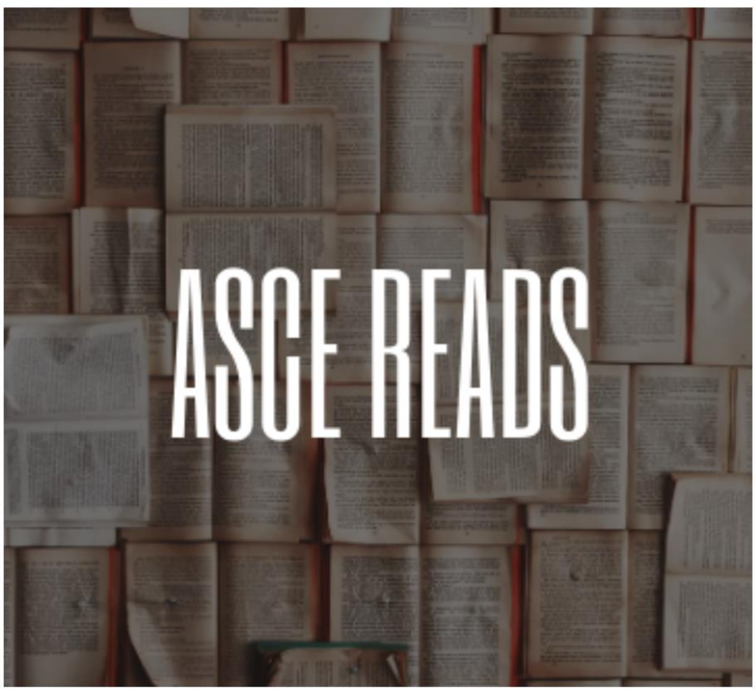


ASCE Reads is a regular series on ASCE News highlighting the latest titles from the ASCE Library, giving you an in-depth look at cutting-edge research and innovations in the civil engineering industry.

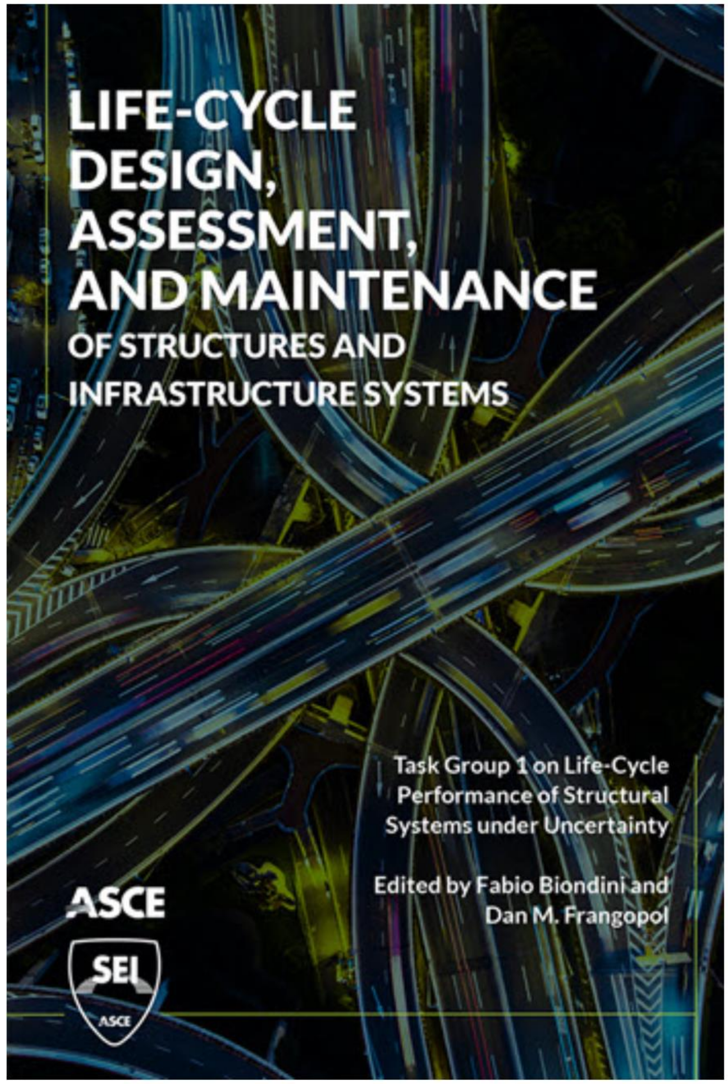
Life-cycle analysis of infrastructure, by its very nature, requires time.

"We've made significant progress during the past decade, but there's a long way to go," said Dan Frangopol, Sc.D, P.E., F.EMI, F.SEI, Dist.M.ASCE, the Fazlur R. Khan Endowed Chair of structural engineering and architecture at Lehigh University.

Frangopol's groundbreaking research into infrastructure from a holistic perspective has earned him a reputation in the civil engineering community as the "Father of Life-Cycle Analysis."

But such long-term, big-picture thinking isn't something that can plug right into the industry and show immediate results.

"I'm optimistic. I think we will have a lot of success implementing these concepts in the future. But success will have to be measured in years, perhaps decades, not days or months," Frangopol said.



Frangopol has joined his fellow pioneer of life-cycle concepts Fabio Biondini as co-editors of a new ASCE book, "Life-Cycle Design, Assessment, and Maintenance of Structures and Infrastructure Systems," providing a comprehensive report on the current status and research needs in the life-cycles of civil structures and infrastructure systems.

The book itself is a sign of the progress Frangopol referenced; it is a product of the ASCE Structural Engineering Institute's Technical Council on Life-Cycle Performance, Safety, Reliability and Risk of Structural Systems.

The book captures the council's recent work to further research and collect information about the latest life-cycle concepts – including results of an international workshop, hosted by ASCE, and a survey.

The council found that two topic areas emerged as critical to life-cycle cost analysis in civil engineering: the need to close a gap between life-cycle theory and practice; and the need to gather more data about existing structural infrastructure to better calibrate life-cycle models under uncertainty.

"Existing models are quite advanced and well-developed, but still we need a bigger effort in calibration and experimental validation," said Fabio Biondini, Ph.D., C.Eng, F.SEI, F.ASCE, professor of structural engineering and chair of the civil engineering degree programs at Politecnico di Milano.

“Life-Cycle Design, Assessment, and Maintenance of Structures and Infrastructure Systems” includes state-of-the-art research on:

• Physical, chemical and mechanical processes involved in the degradation mechanisms of concrete and steel structures located in severe environments.

• Methods and strategies for life-cycle design and assessment of deteriorating structural systems under uncertainty.

• Life-cycle management concepts for structures and infrastructure networks under uncertainty and the application of such concepts in the management process.

• Principles and implications associated with the scheduling and application of maintenance policies for deteriorating structures and infrastructure networks.

So much of all the research relies on taking a systems approach to infrastructure, Frangopol said. And as more civil engineers focus more on the systems level, life-cycle considerations will inevitably follow.

“You have to consider the concept of time. Time is the key issue,” Frangopol said.

“Another area of development is new materials and their implications for life-cycle performance. For example, a new type of steel called A1010 was developed in the U.S. This material costs more than conventional painted carbon steel. But you don’t have nearly as much maintenance. As a result, considerable maintenance cost, sometimes twice or three times the initial construction cost, can be saved. So with these new materials, you are investing in a generational system with greater costs at the beginning but reduced costs over the lifetime,” Frangopol said.

Any structural aging and deterioration assessment has to be done on a systems level, Biondini said. Otherwise you fail to consider the indirect costs.

“For example, if you close a bridge partially or totally, this will have an impact on the infrastructure level,” Biondini said. “And for critical infrastructure, this cost may be much larger than the cost of the bridge itself. So this is a very important aspect that has to be taken into account in the decision-making processes.”

ASCE has made life-cycle concepts the centerpiece of its push to close the infrastructure funding gap, issuing its Grand Challenge to significantly reduce the life-cycle costs of infrastructure by 2025.

Civil engineering is currently undergoing a transition towards a life-cycle-oriented design philosophy, and this is promoted and fostered by the International Association for Life-Cycle Civil Engineering, said Frangopol, IALCCE's founding president.

The European Committee for Standardization also has established a working group to incorporate structural robustness and related life-cycle concepts into the Eurocodes.

"Deteriorating systems should be investigated not only with traditional indicators associated with structural safety and reliability, but also considering the effects of potential damage over the life-cycle based on system performance indicators such as redundancy, robustness and resilience," Biondini said. "Looking at the performance of individual structures within an entire infrastructure system on a lifetime scale – this is something that is going to be more and more recognized in the design practice."

Future standards and guidelines should also incorporate life-cycle performance of structures and infrastructure systems under multiple, usually interacting, hazards, Frangopol added.

Learn more about the book at the ASCE Library.

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