Editorial

Digital technologies for structural engineering and design

The Architecture, Engineering and Construction (AEC) industry is facing global challenges. The call for a more sustainable design and construction of our built environment is louder than ever, with the aim to minimize material use, and address the depletion of natural resources and large contribution to greenhouse gas emissions. At the same time, the construction task is significant: a housing shortage, infrastructure reaching the end of its service life, and an existing building stock that must be transformed, to comply with the energy requirements of today and tomorrow. AEC in its current form, however, is known to be highly fragmented, and stagnant in terms of productivity, facing a lack of skilled workers in many countries. The industry may be unequipped to address the challenges ahead.

Fortunately, rapid developments provide new opportunities. Increasing digitization across the full supply chain enables design and construction of the built environment in a more efficient way. The rapidly expanding affordability of computational power leads to design optimization through e.g., parametric modelling, advanced numerical analyses, and structural optimization strategies. To be successful, it is essential that all stages within a building process develop and digitize in a collaborative way, limiting the impact of the weakest link. Digitizing the manufacturing and construction process proved to be challenging so far. But the recent adoption of robotics for construction allows for production of efficient, complex structures, while simultaneously increasing construction productivity through automation.

These digital technologies are promising, but at the same time pose new questions to our field. What is the influence of new, robotic manufacturing technologies on the structural design process, and which freedom (and limitations) do they provide? How to tailor novel materials for such manufacturing processes, which are not (yet) standardized and embedded in codes of practice or historical databases of experimental results? Can we find

a balance between minimizing material use to reduce environmental impact, and structural capacity under varying loading conditions? Which stakeholders play a role in a complete digital workflow, and when and how do they communicate and make decisions? These and many other questions should be addressed, for the industry to embrace these novel, digital technologies and reach their full potential.

In this Special Issue we present an overview of the potential and challenges of digital technologies from the perspective of structural engineering and design. We span across scales (from material engineering to design of high-rise towers), and materials (from timber and clay to concrete and steel). We focus on the role of digital design tools to optimize structural topology, evaluate design choices, and learn from and apply data-driven solutions. We evaluate digital manufacturing techniques, such as 3D printing and robotic timber milling, and how these manufacturing processes influence the design process. Finally, we address how complete digital workflows, from design to manufacturing, stimulate cross-disciplinary collaborations and lead to highly efficient processes.

This collection of works from academics and practitioners combined, illustrates the scientific challenges being addressed, and the benefits being reaped by industrial adopters of digital technologies. While we stand at the very beginning of the digital transformation of AEC, and the research field will remain relevant for decades to come, this Special Issue confirms that the course has been set to answer the urgent productivity and sustainably challenges successfully.

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