mathematics

MDPI

Editorial

Resilient Infrastructure: Mathematical Modeling, Assessment, and Smart Sensing

Zhongkai Huang [1,2,*], Dongming Zhang [1,2], Xingtao Lin [3], Dianchun Du [4] and Jinzhang Zhang [1,2]

[1] Key Laboratory of Geotechnical and Underground Engineering of the Ministry of Education, Tongji University, Shanghai 200092, China; 09zhang@tongji.edu.cn (D.Z.); zhangjz@tongji.edu.cn (J.Z.)
[2] Department of Geotechnical Engineering, College of Civil Engineering, Tongji University, Shanghai 200092, China
[3] College of Civil and Transportation Engineering, Shenzhen University, Shenzhen 518061, China; xtlin@szu.edu.cn
[4] School of Civil Engineering, Southeast University, No.2, Southeast University Road, Jiangning District, Nanjing 211189, China; dudianchun@seu.edu.cn
* Correspondence: 5huangzhongkai@tongji.edu.cn

MSC: 74S05; 65Z05; 00A06

As big cities become more dense, there is a growing demand for infrastructures, i.e., buildings, bridges, rail transit, pipelines, and utility tunnels. These facilities function as cross-scale complex network systems [1–3], and their serviceability is closely related to human life in terms of transportation, water conveyance, and energy supply. However, coupled with unseen strata and uncertain environments, even small variations in the system could lead to failure under extreme situations [4,5]. Such accidents have been reported repeatedly around the world, resulting in tremendous economic and social losses. Therefore, it is essential to enhance the resilience of infrastructures using multiple modern mathematical technologies. The National Academy of Sciences of the United States defines resilience as the ability to prevent, bear, recover, and adapt to adverse events. Thus, resilient infrastructures must be capable of avoiding catastrophic engineering failures and rapidly recovering its serviceability [6]. We proposed this Special Issue to build a stage for communicating the most recent progress in achieving resilient infrastructure via advanced mathematical modeling, risk assessment, and smart sensing technologies. It is believed that building resilient infrastructures will establish a more resilient and sustainable city.

Resilient infrastructure is crucial for ensuring the sustained functionality of essential systems in the face of various challenges, including natural disasters, climate change, and other unforeseen events [7]. The purpose of this Special Issue is to introduce advanced methods in the mathematical modeling of engineering problems, assessment, and smart sensing of essential infrastructures to address practical challenges in related fields. This Special Issue will provide a platform for researchers to share their insights, methodologies, and innovations in enhancing the resilience of critical infrastructure.

The response of the scientific community was significant, with a total of twenty-three papers being submitted for consideration, of which ten were accepted for publication after attentive peer review by respected reviewers in the fields of the papers.

As the Guest Editors for this Special Issue, we are delighted to bring the "Resilient Infrastructure: Mathematical Modeling, Assessment, and Smart Sensing" Special Issue to a close. This collection of articles has provided an insightful and comprehensive exploration of the multifaceted aspects involved in enhancing the resilience of critical infrastructure. The contributions to this Special Issue have been diverse, covering a wide range of topics within the overarching theme. From advanced mathematical modeling techniques to innovative smart sensing technologies, the articles collectively showcase the depth and breadth of research being conducted in the field.

check for updates

Citation: Huang, Z.; Zhang, D.; Lin, X.; Du, D.; Zhang, J. Resilient Infrastructure: Mathematical Modeling, Assessment, and Smart Sensing. *Mathematics* **2023**, *11*, 4816. https://doi.org/10.3390/math11234816

Received: 11 November 2023
Accepted: 20 November 2023
Published: 29 November 2023

One of the key takeaways from this Special Issue is the importance of adopting a holistic approach to resilient infrastructure. The integration of mathematical models, robust assessment methodologies, and smart sensing technologies has emerged as a powerful strategy for fortifying infrastructure against various challenges, including natural disasters, climate change, and unforeseen disruptions.

The inclusion of original research articles, review papers, and practical case studies has enriched the content, providing readers with a well-rounded understanding of the current state of resilient infrastructure research. The success stories shared in the case studies, along with the lessons learned from past failures, contribute valuable insights that can guide future research and real-world applications.

In conclusion, we extend our sincere appreciation to all the authors who have contributed their research to this Special Issue, the peer reviewers who dedicated their time and expertise, and the editorial team for their support throughout the process. We hope that this Special Issue serves as a catalyst for continued advancements in the field of resilient infrastructure and inspires further research and innovation.

Author Contributions: Conceptualization, Z.H., D.Z., X.L., D.D. and J.Z.; methodology, Z.H., D.Z., X.L., D.D. and J.Z.; writing-original draft preparation, Z.H.; writing-review and editing, Z.H., D.Z., X.L., D.D. and J.Z.; project administration, Z.H. All authors have read and agreed to the published version of the manuscript.

Funding: The first author was supported by the National Natural Science Foundation of China (grant No. 52108381, 52238010, and 52090082), the Shanghai Science and Technology Committee Program (grant No. 22dz1201202, 21dz1200601, 20dz1201404, and 22XD1430200), and the Natural Science Foundation of Chongqing, China (No. CSTB2023NSCQ-MSX0808).

Conflicts of Interest: The authors declare no conflict of interest.

References

1. Joyner, M.D.; Sasani, M. Building performance for earthquake resilience. *Eng. Struct.* **2020**, *210*, 110371. [CrossRef]
2. Decò, A.; Bocchini, P.; Frangopol, D.M. A probabilistic approach for the prediction of seismic resilience of bridges. *Earthq. Eng. Struct. Dyn.* **2013**, *42*, 1469–1487. [CrossRef]
3. Feng, Z.H.; Ma, Q.; An, Z.; Ma, H.; Bai, X. New Fatigue Life Prediction Model for Composite Materials Considering Load Interaction Effects. *Int. J. Appl. Mech.* **2023**, *15*, 2350076. [CrossRef]
4. Compton, P.; Dehkordi, N.R.; Sarrouf, S.; Ehsan, M.F.; Alshawabkeh, A.N. In-situ Electrochemical Synthesis of H_2O_2 for P-nitrophenol Degradation Utilizing a Flow-through Three-dimensional Activated Carbon Cathode with Regeneration Capabilities. *Electrochim. Acta* **2023**, *441*, 141798. [CrossRef]
5. Fathianpour, A.; Jelodar, M.B.; Wilkinson, S.; Evans, B. Resilient Evacuation Infrastructure; an Assessment of Resilience toward Natural Hazards. *Int. J. Disaster Resil. Built Environ.* **2023**, *14*, 536–552. [CrossRef]
6. Huang, Z.K.; Ning, C.L.; Zhang, D.M.; Huang, H.W.; Zhang, D.M.; Argyroudis, S. PDEM-based Seismic Performance Evaluation of Circular Tunnels under Stochastic Earthquake Excitation. *Georisk Assess. Manag. Risk Eng. Syst. Geohazards* **2023**, *18*, 1–13. [CrossRef]
7. Xu, M.; Pang, R.; Zhou, Y.; Xu, B. Seepage Safety Evaluation of High Earth-rockfill Dams Considering Spatial Variability of Hydraulic Parameters Via Subset Simulation. *J. Hydrol.* **2023**, *626*, 130261. [CrossRef]