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Recent Developments in Structural Engineering and Sustainable Concrete Materials

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SUMMARY

The rapid growth of infrastructure development and urbanization has increased the demand for innovative, durable, and sustainable construction technologies. Structural engineering and concrete material technology continue to evolve in response to challenges related to safety, environmental sustainability, material efficiency, and structural performance. Researchers and engineers are actively exploring advanced analytical methods, alternative construction materials, and improved design approaches to enhance the resilience and sustainability of civil engineering infrastructure. This editorial presents a collection of recent studies focusing on structural engineering applications and sustainable concrete materials. The selected papers cover various important topics, including seismic load analysis of buildings, bridge structural performance under traffic and overloading conditions, and the utilization of industrial and agricultural waste materials in concrete technology. These studies reflect the growing interest in integrating engineering performance with environmentally responsible construction practices.

Several papers investigate structural behavior and infrastructure reliability through analytical and experimental approaches. The seismic load analysis of laboratory buildings using the equivalent static method provides valuable insights into structural safety under earthquake loading. In addition, studies related to bridge superstructure capacity and composite steel I-girder bridge performance contribute to the understanding of infrastructure durability and load-bearing capacity in transportation engineering.

Other contributions emphasize sustainable concrete technology through the incorporation of supplementary materials such as fly ash and sugarcane bagasse ash. These materials have shown significant potential in improving concrete properties while simultaneously reducing environmental impacts associated with

cement production and industrial waste disposal. The exploration of foamed concrete and the use of superplasticizers further demonstrate ongoing innovations aimed at enhancing material performance and construction efficiency.

Bunyamin et al. [1] concluded that the laboratory building analyzed using the equivalent static method demonstrates adequate seismic performance according to SNI 1726:2019 requirements. The structure shows acceptable fundamental period values, base shear resistance, and inter-story drift performance under earthquake loading conditions. Although slight differences were observed between the X- and Y-directions due to variations in structural mass and stiffness distribution, the overall displacement and drift values remained within the allowable safety limits. These findings indicate that the building possesses satisfactory structural stability and serviceability against seismic actions.

Munawir et al. [2] stated that the incorporation of fly ash significantly influences the workability and compressive strength of foamed concrete used for lightweight embankment applications. Higher fly ash replacement levels tended to reduce both flowability and early-age strength performance. Among the tested mixtures, the 10% fly ash substitution demonstrated the most optimal balance between mechanical performance and material efficiency, while still satisfying the required strength criteria for lightweight embankment construction on soft soil areas. The study highlights the potential of moderate fly ash utilization as a sustainable and technically suitable alternative in foamed concrete production.

Hady et al. [3] summarized that the composite steel I-girder bridge evaluated in this study exhibits adequate serviceability performance under overload conditions, particularly in terms of deflection limits. However, the structural capacity assessment based on the LRFD approach indicates that certain girder components exceed the allowable strength limit under the 8-truck loading scenario, suggesting potential safety concerns. The findings emphasize the importance of detailed structural evaluation for existing bridges subjected to increasing traffic loads and highlight the need for possible strengthening measures to maintain long-term structural safety and reliability.

Bunyamin et al. [4] highlighted that the Krueng Raba Bridge superstructure demonstrates sufficient structural capacity to withstand increasing traffic loads based on the LRFD analysis and incremental loading simulations. The bridge was found to safely accommodate loading equivalent to seven trucks under the most critical loading configuration while still meeting the required strength criteria. Although the structural capacity ratio remained within acceptable limits, excessive deflection was identified as a serviceability issue that may require structural improvement measures, such as camber adjustments, to enhance long-term bridge performance and operational reliability.

Meillyta et al. [5] reported that the combined use of sugarcane bagasse ash (SBA) and superplasticizer can enhance the compressive strength performance of Portland cement concrete when applied at an optimal replacement level. The study found that a 10% SBA substitution with 1% superplasticizer produced the highest compressive strength compared to other mixtures, demonstrating the beneficial effects of pozzolanic reactions and improved particle packing. However, excessive SBA replacement negatively affected concrete strength due to reduced activity. The findings indicate that optimized SBA incorporation has strong potential as a sustainable supplementary cementitious material for environmentally friendly concrete production.

Overall, the papers presented in this collection highlight current research trends and technological advancements in structural engineering and sustainable construction materials. It is expected that these studies will contribute to future developments in resilient infrastructure, environmentally friendly construction practices, and innovative engineering solutions for modern society.

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Conflict of Interest

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Author Contributions

Ramadhansyah Putra Jaya: writing, reviewing and editing. Reza Pahlevi Munirwan: writing, re-viewing and editing.

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During the preparation of this work, the authors used ChatGPT to enhance the clarity of the writing. After using the ChatGPT, the authors reviewed and edited the content as needed and take full responsibility for the publication's content.

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