

## Special issue “Extreme Sciences and Engineering II”

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# Special Issue “Extreme Sciences and Engineering II”

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## 1. Introduction

Disruptions in the operations of our countries’ infrastructures can undermine the function of our societies and their economies. Such disturbances can result from various risks and uncertainties about installations and systems [1,2]. Many recent incidents have caused repercussions among the impacts of disruptions. New ideas and innovation for comprehensive, yet installation-specific approaches are necessary to secure the integrity of existing or future, public or private, connected and interdependent assets, installations, and infrastructure systems. New technologies (e.g., digital twins, remote sensing, quantum sensors, artificial intelligence, etc.) [3,4] could lead to revolutionary changes in management and maintenance of our infrastructure systems and their assets, contributing to a circular economy. This Special Issue, ‘Extreme Sciences and Engineering II’, enables transparent, fair, and rapid distribution of research highlighting the role of mechanics, sciences, and engineering in multidisciplinary areas across materials science, physics, and engineering. Sixteen papers were submitted to this Special Issue, with a 50% acceptance rate.

## 2. Insights into Material Behaviours

Heitor et al. [5] presented the role of soil stabilisation in halting volumetric deformation and associated reduction in shear strength derived from the wetting processes (e.g., rainfall periods), which was examined for an expansive soil. Two stabilizers commonly used in road construction are examined, i.e., hydrated lime and Portland cement. An additional non-traditional stabiliser composed of a blend of ground granulated blast furnace slag and hydrated lime was also considered. A series of one-dimensional swelling and direct shear box tests were conducted, adopting vertical stresses relevant for pavements and simulate wetting process that can take place after a period of rainfall. Results indicated that while all stabilisers contribute to a reduction in swelling and smaller losses in shear strength upon wetting, the blend of blast furnace slag and hydrated lime is the most favourable in terms of carbon footprint.

Guo et al. [6] discovered new findings for rotating machinery in cold and humid regions that are prone to icing. A cylinder rotating around the vertical axis was selected as the research object in this study. Three cylinders with different diameters were selected, and icing tests were carried out under different tip speed ratios (TSR) in a self-built icing wind tunnel. The icing characteristics were quantitatively assessed using characteristic parameters, including the icing area, the dimensionless icing area, the stagnation point thickness and the dimensionless stagnation point thickness. The research findings in this study have laid the theoretical and experimental foundations for further exploring VAWT icing in depth.

Sengsri and Kaewunruen [7] highlighted a novel meta-functional auxetic unit (MFAU) cell designed to improve performance and weight ratio for structural bridge bearing applications. Robust numerical simulations were conducted using three-dimensional finite element models validated by full-scale experimental results. The validated models were later exposed to compression and buckling actions to identify structural failure modes, with special emphasis on the global behaviours of the meta-functional auxetic (MFA)



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composite bridge bearing. Numerical predictions of the elastic local critical buckling loads of the MFAU cell were in excellent agreement with both the analytical and experimental results, with an observed discrepancy of less than 1%. These results demonstrated that local buckling failures of MFAU cells can potentially be incurred prior to yielding under compression due to their slenderness ratios. Surprisingly, the designed sandwich core used in the MFA composite bridge bearing model can mimic an auxetic structure with significant crashworthiness, implying that this novel core composite structure can be tailored for structural bridge-bearing applications.

### 3. Insights into Systems Behaviours

Ngamkhanong et al. [8] showcased a breakthrough discovery that highlights the buckling phenomena of interspersed railway tracks, which are usually adopted during railway transformations from timber to concrete sleeper tracks in real-life practices globally. The insight into interspersed railway tracks derived from this study will underpin the life-cycle design, maintenance, and construction strategies related to the use of concrete sleepers as spot replacement sleepers in ageing railway track systems. The method provides an indicative reference for innovative design and maintenance for stability and misalignment management of ballasted railway tracks.

Alawad et al. [9] developed an innovative framework for intelligent risk-management systems in the railway industry. The adaptive neuro-fuzzy inference system (ANFIS) was adopted to improve risk management and manage uncertainties in risk variables. This study is the first to establish the hybrid artificial intelligence (AI) model, which can manage risk uncertainties and learns through artificial neural networks (ANNs) via integrated training processes. The prediction result shows very high accuracy in predicting the risk level performance and proves the AI model's capability to learn, make predictions, and capture risk-level values in real time. Such risk information is extremely critical to decision-making processes in managing safety and risks, especially when uncertain disruptions incur (e.g., COVID-19, disasters, etc.). The novel insights provided by this study will lead to more effective and efficient risk management for single and clustered railway station facilities, and the creation of safer, smarter, and more resilient transportation systems.

Kaewunruen et al. [10] determined linear and geometrically non-linear behaviour of the spider-web structures considering different structural patterns and material properties. The new findings exhibited the non-linear dynamic phenomena of spider-web systems subject to large amplitude precursors stemming from extreme winds, large deformation, material imperfections, hostile climatic conditions, etc. This study enabled new discoveries and insights by enhancing large deformable finite elements with the energy method. The novel insights can be used as a reference for the analysis, design, inspection and maintenance of structural membranes, netting cables (or cable-like structures such as rail overhead conductors), tensegrity structures, soft tissues and soft matter, and other bio-inspired structures.

Kessai et al. [11] analysed the drill-bit deformations caused by the stick–slip vibration phenomenon, which is characterized by high frequency and high amplitude in rotary drilling systems. In oil and gas industry, rotary drilling systems are used for energy exploration and productions. The results were validated by a case study of MWD (measurement while drilling) data of a well located in a Southern Algerian oil field. The results provide a preventive maintenance planning and strategy for drill bits in rotary drilling systems under harmful torsional vibrations during the drilling process.

Lima et al. [12] evaluated that railway-engineered interspersed concrete (EIC) sleepers can successfully replicate the stiffness of timber sleepers installed in tracks using field instrumentation installed under revenue-service train operations on a North American commuter rail transit agency to measure the wheel–rail vertical loads and track displacement. The results indicated that there are minimal differences in median track displacements between timber (2.26 mm, 0.089 in.) and EIC sleepers (2.21 mm, 0.087 in.). Using wheel-load data and the corresponding track displacements associated with each wheel load, track modu-

lus values were calculated using the single-point load method based on beam on elastic foundation (BOEF) fundamentals. The field results confirmed the suitability of the new EIC sleeper design in maintaining a consistent track modulus for the location studied, evenly sharing loads between and among sleepers manufactured from both concrete and timber.

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