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EDITED AND REVIEWED BY
Guoqiang Li,
Louisiana State University, United States

*CORRESPONDENCE
Denis Benasciutti,
denis.benasciutti@unife.it

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Editorial: Structural integrity and durability of engineering materials and components

Denis Benasciutti[1]*, José A. F. O. Correia[2], Shahrum Abdullah[3] and Jan Papuga[4]

[1]Department of Engineering, University of Ferrara, Ferrara, Italy, [2]Faculty of Engineering, University of Porto, Porto, Portugal, [3]Universiti Kebangsaan Malaysia, Bangi, Malaysia, [4]Faculty of Mechanical Engineering, Czech Technical University in Prague, Prague, Czech Republic

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Editorial on the Research Topic
Structural integrity and durability of engineering materials and components

Engineering components and structural details may be subjected in service to quite different loading conditions: high-cycle or low-cycle fatigue (with constant or variable amplitudes), static loadings and/or overloads, vibrations, creep, stress corrosion–just to cite a few examples. Whatever the loading condition, an assessment of the structural integrity for a structural detail must ensure an adequate safety margin against unexpected failures with potential catastrophic consequences. This goal is pursued by the use of theoretical, numerical and experimental approaches, often combined. For example, laboratory tests to estimate fundamental material properties, or full-scale tests to validate a finite element analysis implementing suitable strength models. Most often, scientific research deals with each of these areas separately, by proposing unconventional strength criteria, developing numerical techniques, or testing the durability of specific categories of traditional and advanced materials.

The four papers of this Research Topic address some of the above-mentioned Research Topic by means of theoretical and/or experimental studies that cover application areas from mechanical to civil engineering. The paper by Gaidai et al. presents an approach to predict the extreme response in the mooring system of a floating wind turbine (FWT) based on extreme value statistics and a bivariate correction approach. As a case study, the approach is applied to a 10 MW large three-bladed FWT. The fully coupled aero-hydro-elastic-servo dynamic analysis of the FWT is performed by the open source simulation tool FAST (Fatigue, Aerodynamics, Structures and Turbulence). The FAST tool computed the aerodynamic loads on the blades and hydrodynamic loads on semi-submersible floater, other than the structural dynamic response, and eventually returned the time series of anchor tension force and surge motion of the wind turbine under different operation conditions, to be processed in the subsequent statistical analysis. A novel bivariate correction statistical method, proposed to enhance the Average Conditional Exceedance Rate (ACER) method, was employed to model the FWT extreme response for a 5-year return period prediction with a 95% confidence interval, based on just 2 min short response record. The obtained results demonstrated how the proposed bivariate correction method allows for more robust and precise predictions of the coupled surge motion and anchor tension response of the FWT, especially when the available data record is too short.

The paper by Jauregui-Correa et al. presents a health monitoring and crack damage detection approach of a subway structure based on acceleration data recorded on a railcar. Accelerations are converted into track deformations (strains) by a transfer function calibrated on data measured on a train running along the track of a special scaled-down experimental facility. Accelerations were recorded by a six degree of freedom MEMS accelerometer, whereas track deformations were measured by strain gauges fixed at various locations along the track. Acceleration and strain time signals recorded in the tests were subsequently analyzed by the Empirical Model Decomposition (EMD) method to identify "intrinsic modes" with specific characteristics. The obtained modes formed the database used for estimating the transfer function between railcar acceleration and track deformation. This transfer function, when applied to any acceleration signal, allows the track deformations to be estimated without the need of direct measurements. The transfer function proved to be a very useful tool for the health monitoring and crack damage detection of a substructure in a real subway system, in which direct measuring of track deformation was too complicated and expensive. In the case study presented in the paper, the system health monitoring only relied on the accelerations measured on a railcar bogie. The obtained results pointed out the capabilities of the proposed method in detecting failures in a subway system.

The article by Liu et al. develops an analytical model aimed at investigating the time-dependent mechanical behavior of shear stud connections (SSC) in composite steel-concrete constructions subject to long-term loading. A model of beam on viscoelastic foundation, which included a time-dependent spring stiffness to represent creep properties of concrete, was used to compute the time-dependent mechanical response of the connection. The obtained governing equations of the connection were solved for the case of moderate and long beam geometries, yielding closed-form solutions that were finally compared against results from a three-dimensional finite element model, showing a close agreement. The article concluded with a sensitivity analysis that scrutinized the effect of some design parameters (e.g. stud height and diameter, concrete strength, loading age).

The article by Mat Saliah and Md Nor aimed at monitoring the structural integrity of reinforced concrete (RC) beams laminated with carbon fiber-reinforced polymer (CFRP) by means of non-destructive acoustic emission technique. The effect of CFRP reinforcement was highlighted by comparison with results from a RC beam without CFRP. In laboratory tests, beams were subjected to three-point monotonic loading until failure; acoustic emission sensors mounted on the beams monitored the onset and progression of cracks and allowed the identification of crack modes. When compared to the behavior of the reference beam without CFRP, the beam strengthened with CFRP presented an increase in load-bearing capacity. Results also pointed out the effectiveness of the acoustic emission technique in detecting and monitoring crack damage under monotonic loading.

Author contributions

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Conflict of interest

The authors declare that the research was conducted in the absence of any commercial or financial relationships that could be construed as a potential conflict of interest.

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