IGF29 - 29th Int.Conf. on Fracture and Structural Integrity

Monday, 15 February 2027 - Wednesday, 17 February 2027

Vicenza, Italy

Scientific Programme

Analytical and Numerical Fatigue Assessment

This track focuses on advanced theoretical models and computational methodologies to predict fatigue life and crack propagation in materials and structures. Key topics include finite element modeling (FEM), boundary element methods (BEM), extended FEM (XFEM), and multi-scale simulations. It addresses deterministic and probabilistic approaches to evaluate damage accumulation under constant and variable amplitude loading. The session aims to bridge the gap between complex mathematical formulations and practical engineering software, providing reliable tools for structural design against fatigue failure.

Experimental Mechanics and Fracture Testing

Dedicated to the latest advancements in experimental techniques for characterizing material degradation and fracture toughness. Contributions cover standardized testing (e.g., KIC, Jintegral, CTOD) as well as innovative non-destructive evaluation (NDE) and structural health monitoring (SHM) methods. Highlights include digital image correlation (DIC), acoustic emission, thermography, and high-resolution microscopy. This track emphasizes real-time damage tracking, in-situ testing under extreme environments, and the validation of numerical models through high-fidelity experimental data.

Additive Manufacturing: Integrity and Defect Tolerance

Additive Manufacturing (AM) introduces unique challenges regarding structural integrity due to anisotropic properties, surface roughness, and process-induced defects like porosity or lack of fusion. This track explores the fatigue behavior, fracture resistance, and life-prediction models for 3D-printed metals, polymers, and ceramics. Focus is placed on post-processing treatments (e.g., HIP, shot peening), defect-tolerance design philosophies, and the development of tailored testing protocols to ensure the safe deployment of AM components in critical industries like aerospace and biomedical.

Environmental Degradation and Hydrogen Embrittlement

Structures often operate in aggressive environments that accelerate failure. This track addresses the synergistic effects of mechanical stress and chemical degradation. Key focus areas include stress corrosion cracking (SCC), corrosion fatigue, high-temperature oxidation, and crucially, hydrogen embrittlement in the context of the energy transition. Papers will discuss microstructural degradation mechanisms, predictive modeling of environment-assisted cracking, and the development of advanced materials or coatings designed to withstand harsh operating conditions in chemical, marine, and energy sectors.

Multi-scale and Multi-physics Fracture Mechanics

Modern structural integrity requires understanding failure from the atomistic scale up to macro-structures. This track covers continuum mechanics, crystal plasticity, molecular dynamics, and phase-field modeling of fracture. It also embraces multi-physics coupling, where mechanical failure interacts with thermal, electrical, or magnetic fields (e.g., in smart materials, batteries, and electronic packaging). The goal is to foster holistic approaches that capture how microscopic damage evolves into catastrophic macroscopic failure across diverse material classes.

Structural Integrity of Welded and Bonded Joints

Welding, brazing, and adhesive bonding are critical joining techniques prone to defects, residual stresses, and microstructural heterogeneity. This session focuses on the fatigue and fracture assessment of traditional welds (e.g., arc welding) and advanced joining methods (e.g., Friction Stir Welding, laser welding, and structural adhesives). Topics include the evaluation of residual stress fields using diffraction techniques, local strain approaches, master S-N curves, and fitness-for-service (FFS) assessments to ensure the reliability of joined assemblies in civil and industrial infrastructure.

Composites, Metamaterials, and Sandwich Structures

Anisotropic and heterogeneous materials demand specialized fracture criteria. This track explores damage mechanisms—such as delamination, matrix cracking, fiber breakage, and debonding—in fiber-reinforced polymers (FRPs), laminated composites, sandwich panels, and mechanical metamaterials. Contributions will highlight progressive failure analysis, impact resistance, debonding kinetics, and the optimization of architectures for enhanced fracture toughness. The session aims to advance lightweight design strategies for automotive, aerospace, and wind energy applications where structural reliability is paramount.

Rock Mechanics, Geostructures, and Infrastructure Integrity

This track bridges structural integrity with civil, geopolitical, and environmental engineering. It covers the fracture and failure behavior of concrete, rocks, masonry, and geomaterials. Key topics include damage evolution in historical buildings, tunnels, dams, and transport infrastructures under cyclic, seismic, or environmental loads. Furthermore, it addresses rock fracturing related to geothermal energy exploitation, carbon capture and storage (CCS), and mining activities, focusing on long-term durability, structural health assessment, and retrofitting strategies.

Artificial Intelligence and Data-Driven Structural Integrity

The digital transformation of engineering leverages Machine Learning (ML) and Artificial Intelligence (AI) to revolutionize failure prediction. This track explores physics-informed neural networks (PINNs), deep learning for automated defect detection in NDE images, data-driven remaining useful life (RUL) estimation, and digital twins of complex structures. The session highlights how massive data streams from SHM sensors can be integrated with classical mechanics to build adaptive, intelligent systems for predictive maintenance and real-time structural health

management.

Failure Analysis, Case Studies, and Industrial Regulations

The ultimate validation of fracture mechanics lies in industrial practice. This track welcomes real-world case studies, forensic engineering reports, and failure analyses from various sectors (railway, oil & gas, power generation, biomechanics). It also addresses the evolution of international standards, fitness-for-service codes (e.g., BS 7910, API 579, FITNET), and risk-based inspection methodologies. The goal is to share lessons learned from structural failures, promote best practices, and align academic research with the safety and regulatory needs of modern industry.

Novel Horizons, Interdisciplinary Topics, and Open Tracks

This track serves as an open forum for cutting-edge, non-conventional, and highly interdisciplinary research that transcends traditional boundaries of fracture mechanics. It welcomes exploratory studies, emerging paradigms, and novel methodologies that do not strictly fit into the previous tracks. Topics may include bio-inspired fracture resilience, nanoscale failure in quantum materials, structural integrity in extreme space environments, historical overviews, and innovative pedagogical approaches to teaching mechanics. This session aims to foster cross-disciplinary synergy, inspiring new lines of inquiry and unconventional solutions for the structural integrity challenges of tomorrow.