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Spectral finite element methods in dynamics

Haojie Xu, Yuqian Fan

Research article Page: 01-15

Spectral finite element methods (SFEM) in dynamics extend classical finite element analysis by using exact wave solutions and frequency-dependent dynamic shape functions derived from governing differential equations, enabling precise modeling of wave propagation with minimal elements. Unlike polynomial-based FEM, which requires mesh refinement at high frequencies, SFEM employs Fourier transforms to handle broadband excitations, assembling exact spectral stiffness matrices at discrete frequencies for beams, plates, frames, and continua. This approach excels in transient dynamics, structural health monitoring, and seismic analysis, capturing all wave modes ,.…… [For more click here]

Probabilistic Seismic Hazard Assessment for Urban Infrastructure Networks

Ole Sigmund, Y. M. Xie & X. Huang

Research article Page: 16-28

Probabilistic seismic hazard assessment (PSHA) for urban infrastructure networks integrates deaggregation of hazard curves with fragility functions to quantify exceedance probabilities of ground motions and component damages across interconnected systems. Monte Carlo simulations model uncertainties in source parameters, attenuation, and network topology, estimating link disruption probabilities from bridge failures and debris blockages with return periods of 200-2475 years. Network-level metrics like TCWSD evaluate post-event functionality loss, revealing cascading effects where 10-20% component damage disrupts 30-50% system capacity in dense urban grids. Advanced frameworks such as SYNER-G incorporate interdependencies, enabling resilience optimization for transportation, utilities, and lifelines under scenario and probabilistic hazards. ..…… [For more click here]

Development of Lightweight Foamed Concrete for Energy-Efficient Building Envelopes

Michael Yu Wang

Research article Page: 29-46

Development of lightweight foamed concrete for energy-efficient building envelopes involves incorporating surfactants to generate stable air bubbles in cement paste, achieving densities of 300-800 kg/m³ and thermal conductivities as low as 0.06-0.15 W/m·K. This porosity enhances insulation performance, reducing building energy consumption by 30-50% for heating/cooling compared to normal concrete, while maintaining compressive strengths of 1-10 MPa suitable for non-loadbearing walls. Optimized mixes with lightweight aggregates, phase-change materials (PCMs) in micropores, and polymer fibers provide acoustic damping, fire resistance, and up to 75% porosity without compromising handling or durability. Prefabricated panels integrate foamed concrete with steel frameworks, minimizing embodied carbon (302-508 kg $CO2/m^3$) and enabling rapid assembly for sustainable envelopes…… [For more click here]

Fatigue Performance of Orthotropic Steel Bridge Decks under Vehicular Loading

Liyong Tong & Ting-Nung Shiau
Research article Page: 47-66

Fatigue performance of orthotropic steel bridge decks under vehicular loading is critically assessed using high-fidelity 3D finite element models incorporating vehicle transverse distribution models (VTDM) to capture stress ranges at weld details like deck-to-ribbon joints and diaphragm cutouts. Traffic-induced cyclic stresses lead to premature cracking at vulnerable sites, with full-bridge Arlequin analyses revealing 30-40% higher fatigue stress ranges than local models due to global deformations and wheel clustering. Parametric studies show axle overloads reduce fatigue life linearly, while thicker plates (e.g., 20-22 mm) extend life by mitigating hot-spot stresses under Eurocode 3 or BS5400 loading spectra. Diaphragm cutouts emerge as most susceptible, necessitating routine inspections and mitigation via weld improvements or overlays to achieve 100+ year design lives. ..…… [For more click here]

Multi-Hazard Risk Analysis for Critical Infrastructure in Flood-Prone Areas

Ashraf Fawzy & V.D.Desai
Research article Page: 67-82

Multi-hazard risk analysis for critical infrastructure in flood-prone areas employs GIS-based multi-criteria decision analysis (MCDA) and probabilistic models to integrate flood susceptibility, climate projections, and vulnerability indices for assets like roads, power grids, and water systems. Key parameters include rainfall intensity, elevation, slope, drainage density, land use, and proximity to rivers, with rainfall weighted highest (25%) in AHP frameworks identifying 20-30% of areas at high compound risk. Global assessments reveal ~27% of road/rail assets exposed to multi-hazards, with cascading failures disrupting 30-50% network capacity from 10% component damage in urban settings. Standardized fragility curves and Monte Carlo simulations quantify direct/indirect losses, prioritizing reinforcements in zones vulnerable to floods, cyclones, and erosion. …..… [For more click here]

Influence of Curing Conditions on the Microstructure of Alkali-Activated Slag Concrete

Sharad D Kachave, Vijaykumar P. Wani, S. D. Suryawanshi & P. Heider
Research article Page: 83-98

Curing conditions profoundly influence the microstructure of alkali-activated slag concrete, where heat curing at 50-65°C accelerates slag dissolution and promotes denser C-(N)-A-S-H gel formation with reduced porosity compared to ambient curing. Elevated temperatures enhance early-age reaction kinetics, yielding coarser microstructures with less microcracking but risking delayed hydration inhibition and higher autogenous shrinkage upon cooling. Sealed curing minimizes drying shrinkage by 30-50% through self-desiccation control, fostering hydrotalcite phases in high-MgO slags and a more homogeneous matrix with fewer unreacted grains. Water curing produces the densest microstructure with minimal voids, boosting compressive strength but increasing microcrack risk under non-sealed exposure. …… [For more click here]