Research article, Type: Subscription ***Volume: 12***

Self-healing materials for infrastructure maintenance

Noha.M.Al-Zahrani, Manal.K.Zahrani, Zainab.A.Alfifi & Noura N.

Research article Page: 01-18

Self-healing materials for infrastructure maintenance incorporate bacteria, microcapsules, or expansive agents that autonomously repair cracks up to 0.8mm wide, extending concrete service life by 2-3 times and reducing repair costs significantly. Bacterial concrete uses spores of Bacillus species embedded with calcium lactate nutrients, which activate upon water ingress to precipitate limestone ($CaCO_3$) that seals fissures within 7-28 days. Capsule-based systems release low-viscosity epoxy or silicate polymers when cracks rupture protective shells, achieving 70-90% strength recovery in lab tests. Autogenous healing leverages unhydrated cement hydration in young concrete, enhanced by low w/c ratios and SCMs like fly ash for finer cracks. These technologies align with sustainable practices, minimizing lifecycle emissions through reduced maintenance. ………. [For more click here]

Recycled plastic aggregates in asphalt pavements

Ahmad A.Alshehri, Mohammed A.Attaf & Abdullah S.Alshihry

Research article Page: 19-41

Recycled plastic aggregates in asphalt pavements replace 5-20% of conventional aggregates with processed waste plastics (HDPE, LDPE, PET) to enhance rutting resistance and fatigue life while diverting landfill waste. Shredded or pelletized plastics improve binder-aggregate adhesion, reducing moisture susceptibility and permanent deformation by 30-50% under heavy traffic loads. These mixtures maintain adequate workability with modified mixing temperatures (10-15°C higher) and demonstrate comparable skid resistance to traditional hot-mix asphalt. Environmental benefits include 17% lower energy use and reduced GHG emissions through partial bitumen replacement. This sustainable approach supports circular economy goals in pavement engineering. ………. [For more click here]

Hemp-based insulation materials in cold climates

Himavarshini Bora & N.Dinesh Murali

Research article Page: 42-51

Hemp-based insulation materials excel in cold climates due to their low thermal conductivity (0.040-0.065 W/mK) and high R-value (approximately 3.7 per inch), providing effective heat retention comparable to fiberglass while using renewable, carbon-sequestering hemp fibers and hurds. These natural composites offer superior moisture buffering, preventing condensation and mold growth in humid winters by absorbing and releasing vapor without losing insulating performance. Unlike synthetic foams, hemp insulation maintains stability across temperature swings, improving thermal resistance as conditions cool further, which supports energy-efficient envelopes in high-latitude residential structures. Their breathable structure enhances indoor air quality and acoustic insulation, aligning with sustainable building practices for regions with harsh winters. Field studies confirm lifecycle carbon negativity through rapid hemp growth, offsetting embodied energy over decades of use.

Ultra-high-performance fiber-reinforced concrete

Novaline Jacob & Emmaneual Sanjay Raj
Research article Page: 52-68

Ultra-high-performance fiber-reinforced concrete (UHPFRC or UHPC) achieves compressive strengths exceeding 120-200 MPa through optimized particle packing with silica fume, quartz flour, and high-range water reducers, creating a dense matrix with minimal porosity. Steel microfibers (1-2% volume) provide post-cracking tensile ductility up to 8-10 MPa, enabling thin sections (2-4 inches) for bridges and overlays that resist impact, abrasion, and chloride penetration. Its low permeability (<10^-12 m/s) and high bond strength eliminate traditional rebar in many applications, extending service life beyond 100 years. Sustainability improves via recycled steel fibers and SCMs reducing cement content by 20-30%. This material aligns with your interests in advanced composites and blast-resistant structures.

Phase-change materials for thermal energy storage in buildings

T. Dhivya & A. Royal Edward Williams
Research article Page: 69-80

Phase-change materials (PCMs) for thermal energy storage in buildings store and release latent heat during solid-liquid phase transitions, typically at 18-28°C, stabilizing indoor temperatures and reducing HVAC loads by 20-40%. Common types include paraffin waxes and hydrated salts microencapsulated in gypsum boards or concrete panels to prevent leakage while enabling passive cooling in walls and ceilings. Integration via shape-stabilized composites enhances energy density (150-250 kJ/kg) over sensible storage, with bio-based variants minimizing environmental impact. These systems cut peak demand by absorbing daytime solar gains for nighttime release, aligning with your sustainable construction interests. Challenges include encapsulation durability and cost, addressed through inorganic salt hydrogels.

Thermal cracking control in mass concrete foundations using cooling pipes

Nour Zaher & Abeer Farouk
Research article Page: 81-94

Thermal cracking control in mass concrete foundations using cooling pipes involves embedding PVC or steel pipes in a serpentine pattern during pouring to circulate chilled water, dissipating hydration heat and limiting peak temperatures to 60-70°C. Pipes spaced 1-2m apart with 10-15°C inlet water reduce temperature differentials between core and surface to under 20°C, preventing tensile stresses from exceeding early-age concrete strength. Finite element simulations optimize pipe layout and flow rates (0.5-1.5 m/s) to achieve uniform cooling rates of 1-2°C/hour, avoiding thermal shock around pipe-concrete interfaces. This method cuts cracking risk by 70-90% in large footings (>5m thick), complementing low-heat cement and insulation strategies. Real-time temperature monitoring via embedded sensors guides operation until gradients stabilize.