Theme 3-2: Experimental and Computational Mechanics - 2023

Title	Name of the PI	List the Names of the Co-Is	Department	Abstract	Starting Date	Ending Date	Funding	Amount of Funding
Smart Materials: Hybrid RF-Optical Techniques for Conductive Concrete Characterization	Sherif Yehia	Dr. Taha Landolsi, Dr. Nasser Qaddoumi	CVE	Safety and durability of concrete structures are usually considered during the design phase of the project. However, during the service life of a structure unexpected loading events or combined loading/environmental exposure might introduce stresses not accounted for during the design. Therefore, engineers recommend adopting Structural Health Monitoring (SHM) systems to monitor behavior of structures and take necessary precautions to prevent expensive repairs or to prevent failures. Sensor technology plays a major role in SHM systems. Recently, smart materials such piezoresistive cement-based composites are evaluated as self-sensing materials and are considered for SHM. Conductive concrete is a material developed to achieve high electrical conductivity and high mechanical strength. Carbon powder, graphite, and steel fibers are used to improve the electrical conductivity. The piezoresistive effect of such material could be utilized in SHM applications. The objective of this proposal is to evaluate the effectiveness conductive concrete material developed by the PI at AUS in self-sensing applications. Several techniques are utilized to correlate between the change in the electrical resistivity of the material and strain developed in concrete structures due to loading. Recommendations for the best configuration and implementation of the conductive concrete for self-sensing applications is developed.	01/06/2018	31/05/2020	FRG	148844
Conductive Concrete for Resiliency Smart Citie	Sherif Yehia	Lim Nguyen, University of Nebraska-Lincoln, USA, Nasser Qaddoumi	CVE	The Conductive Concrete Research group from the Department of Civil Engineering (CVE) and the Department of Electrical Engineering (ELE) at the American University of Sharjah (AUS) will conduct an experimental study to determine the shielding effectiveness (SE) of conductive concrete against EMP. Experiments to measure SE of conductive concrete samples and evaluate their performance according to the US military standard (MIL-STD) 188-125-1 specifications for protecting facilities against HEMP [2] will be conducted. The samples are also be tested on compressive and flexural strength according to ASTM standards. The objective of this study is to construct a shielded concrete facility that can protect infrastructure assets critical to a functional smart city such as electrical grids, communications and control centers from EMP threats.	01/06/2020	31/05/2023	FRG	650000
Micromechanics of fracture in cellular solids: a step towards enhanced toughness by design	maen alkhader	wael abuzaid	MCE	The classical role of cellular solids in engineering applications is evolving due to the confluence of the need for new advanced materials and the recent advances in manufacturing technologies (e.g., 3D printing). These technologies have made the fabrication of functionally optimized cellular solids, of any arbitrary constituent material and internal architecture, a reality. However, a comprehensive understanding of the property-microstructure relationship in cellular solids, with an emphasis on failure properties is currently lacking. This has hindered the development of application-tailored cellular solids that can capitalize on progressive 3D printing technologies, which is becoming increasingly available at universities, laboratories, and small to large industries. This proposal implements an integrated approach that combines micro-mechanical modeling and simulations with experimentation to characterize the deformation mechanisms accompanying fracture and crack propagation in different classes of cellular solids with different microstructures and constituent materials (i.e., metallic, ceramic and polymeric). Through this approach, this work aims to elucidate failure and fracture phenomenon in cellular solids in terms of their cellular microstructure (i.e. architecture). Subsequently, this work aims to develop a design framework to control and optimize the macroscopic fracture response of cellular solids by controlling their cellular microstructure at the mesoscale. This framework is based on controlling the topology dependent deformation mechanisms near a crack singularity to induce topology dependent and controlled toughening mechanisms. Ultimately, this work will change the classical view that relates fracture behavior in cellular solids to their porosity, and instead, it will provide a new perspective for designing materials with enhanced fracture toughness. To maximize the impact of this work, fracture and failure will be investigated in commercial cellular solids and in recently developed ones (e.g., auxetic, lattice-based). These emerging cellular solids hold an advantage over their commercial counterparts due to their tailored microstructural features. The proposed work will provide a new perspective that can contribute to advancing the current understanding of fracture phenomenon in heterogeneous materials, composites, and monolithic solids. Hence, this work's impact could be far reaching to include marine, aerospace, automotive, and biomedical industries.	01/06/2020	31/05/2022	FRG	219250
Robustness of Concrete Elements Exposed to Elevated Temperature and Influence of Mix Constituents	Sherif Yehia	Éva Lublóy,Budapest University of Technology, Nasser Qaddoumi Mohamed Elchalakani School of Civil, University of Western Australia,	CVE	The proposed research program aims to develop guidelines and design recommendations for concrete structures exposed to elevated temperature. To achieve this goal, commonly used concrete mixes in the UAE and other new concrete mixes introduced to construction industry such as ultrahigh strength and geopolymer concrete will be considered in the investigation. Possible correlation between aggregate strength and concrete residual capacity after exposure to elevated temperature will be investigated. Numerical thermal analysis will be conducted using finite element program to determine the isotherms in the concrete samples. The analytical models will be validated by comparing the temperature change in the model to that obtained from the experimental investigation at specific embedment depth. In addition, a database of scan electron microscope (SEM) images and thermo-gravimetrical analyses will be utilized in forensic investigations to help assess concrete structures after fire. The expected outcomes of the proposed research will contribute to the state-of-the-art knowledge about performance of concrete structures exposed to high temperature. In addition, the guidelines and design recommendations for concrete structures will provide valuable information to designers in the UAE and around the world to account for thermal loads.	01/06/2023	31/05/2026	FRG	594550
Rehabilitation of Damaged Recycled and Lightweight Beams Using Fiber Cementitious Material	Rafal Habib,	Ali Fakhouri, Kaltham Almheiri, MohamedImbabi	CVE	The research seeks to increase the flexural strength, shear strength, fatigue life, and impact resistance of damaged reinforced concrete beams by injecting epoxy resin and using a composite cover of fibers and cementitious material. Additionally, the project aims to develop a socially, economically, and environmentally sustainable procedure for strengthening the damaged reinforced concrete beams. This research builds on two previous phases and focuses on using fiber cementitious material to rehabilitate pre-damaged beams of lightweight and recycled aggregate. This experiment will discover the proper procedure to bond the new material to the old concrete and determine the required thickness of the cover for cost efficiency. The team will also evaluate the feasibility of using fiber cementitious material to repair pre-damaged beams. Successful completion of this research will highlight the validity of using recycled and lightweight aggregate as a leading alternative for reducing concrete’s environmental impact.	06/03/2023	19/12/2023	URG	7000