Dear Readers,

As newer materials with high-performance attributes get introduced to the construction industry, mechanics of structures built with such materials and construction technology involved thereof are subject matters of investigation leading to resilient infrastructure development. Such cutting-edge technological advancements in engineered construction materials and their applications in real-life civil infrastructure projects leading to resilient infrastructure development are addressed in this edition.

Prof. Vasant Matsagar, our Guest Editor, delivers contemporary knowledge on this emerging topic in the concrete industry with this sequel edition. Prof. Matsagar, who is well-known in both academia and industry, specialises in Multi-Hazard Protective Structures, and is presently serving as Dogra Chair Professor in the Department of Civil Engineering at the Indian Institute of Technology (IIT) Delhi.

Production Editor
Indian Concrete Journal

Dear Colleagues,

Non-corrosive and high-strength fiber-reinforced polymer (FRP) materials are finding their increasing use in infrastructure projects since they have been engineered to provide some of the excellent properties typically desirable for construction materials. Currently, Indian standard on the use of the FRP reinforcing materials is yet to be formalized, while the industry has already been witnessing extensive application of these composites in real-life projects. Though several types of advanced materials are categorized under the engineered materials, the FRP-based internal/ external reinforcing materials are prominently considered to be engineered composites, which are suitably graded based on functionality, i.e. resulting in functionally-graded FRP composites. The application of such advanced engineered materials in construction projects requires newer technologies in enhancing structural capacities and performance under various loading conditions that structures are exposed to. In particular, the advanced engineered materials are employed effectively for achieving higher resisting capacities under the extreme loading caused due to earthquakes, windstorms, blast, and fire exposures. However, understanding underlying mechanics of such advanced materials is essential for them to be effectively utilized in structures gainfully.

With the intent of introducing some newly developed engineered materials through the Indian Concrete Journal (ICJ), understanding their mechanics and construction technologies involved, this theme of "Resilient Infrastructure Development with Advanced Engineered Materials" was originated. Anticipating high number of submissions on this niche area of latest research worldwide, present and sequel issues of the ICJ have been earmarked to publish some of the most recent technological developments on the theme. In the present issue, six such highly-rated research papers have been included, presenting a broad range of topics covering, FRP-wraps, glass fiber-reinforced polymer (GFRP) composite rebars, hybridization of dispersed fibers in concrete, engineered cementitious composite (ECC), and hierarchically engineered cementitious composites.

The first article has dealt with carbon fiber-reinforced polymer (CFRP) π-anchor used in the CFRP U-wrap for shear strengthening of reinforced concrete (RC) beams. Through a series of tests conducted at the McMaster University in Canada on the RC beams strengthened in shear using the CFRP composite material and new technology developed for securely anchoring it, the authors have established effectiveness of the advanced engineered material in enhancing shear performance of the RC flexural members. For improving load-bearing capacity of existing RC members by strengthening, retrofitting, or rehabilitation using the CFRP materials this approach will prove to be quite useful.

The next article has focused on the lightweight and high-strength GFRP reinforcing bars placed near the surface at the soffit of an RC beam for flexural strengthening. The author reports about 25% increase in the flexural strength achieved due to the near surface mounted (NSM) GFRP rebars inserted in the groves in the RC beams. A case study on real-life RC building with its slab-beams strengthened using the NSM GFRP rebars has also been presented in this article. It will be important in future to develop well-established analysis and design procedures for the RC members strengthened using the NSM GFRP rebars to enhance their flexural capacity.

Fiber-reinforced concrete (FRC) is yet another category of engineered materials, wherein different types of chopped fibers are mixed in concrete to improve certain mechanical properties. Hybrid fiber-reinforced concrete with dispersed polypropylene, hooked end steel, and/or crimpled steel fibers in a beam-column joint were used to evaluate its performance under cyclic loading that is typically exerted during earthquakes and the results of experimental programme are presented in the third article. Congestion of stirrups in the beam-column joint may possibly be avoided by using fiber hybridization appropriately in cementitious composites while achieving desired non-linear behavior for enhanced ductility and energy dissipation capabilities. Optimum dosage of different types of fibers in the hybridization for achieving some target performance of the FRC is required to be studied in future.

The fourth article addresses response evaluation of concrete structural element under yet another extreme loading condition arising out of blast events. A steel tube - concrete composite sacrificial wall has been presented to show its effectiveness in mitigating the blast response. In this article, it has been shown that hollow thin mild steel tubes deform and dissipate large amount of input energy, thereby providing greater protection on the rear side of the blast wall, whereas the concrete wall experiences reduced damage under the considered threat scenario. Such newly proposed steel-concrete composite sacrificial/ blast wall will find application in the development of protective structures. Nevertheless, it will be interesting to see if field tests conducted on such sacrificial composite panels yield similar blast protection as predicted from this numerical investigation.

Steel-reinforced engineered cementitious composite (ECC) portal frames have been studied using finite element method (FEM) and the numerical results are reported in the fifth article of this ICJ Special Issue. The detailed non-linear FE modeling and analysis results validated through comparison with the findings from experiments reported in this article will be immensely useful for investigating advanced engineered materials employed in structural frame members in future. Particularly, at the critical sections of the structural members, enhancement in the mechanical properties and thereby performance improvement can be achieved over the conventional RC section by introducing such materials in accordance with the functional requirements. Once again, the discussions on functionally-graded composite materials in civil infrastructure is prompted herein.

Lastly, highly ductile cementitious composite has been reported to be developed using fibers of different length scales such as nano-, micro-, and continuous-fibers. The scientifically developed engineered composite has shown promising performance to be used possibly in the development of resilient infrastructures. As stated before, mixing optimum quantity of different types of such fibers in varying scales in the hybridization process yet remains a research question to seek answer for. Nonetheless, hierarchically engineered cementitious composite materials appear to have potential as civil engineering materials for future.

Thus, these articles have displayed the ongoing research efforts being made towards improving resiliency of infrastructure through advanced engineered materials from different categories and under variety of loading conditions. The articles presented in this ICJ Special Issue have dealt with laboratory-scale experiments to real-life applications through analytical/ numerical simulations. In the upcoming sequel edition, we have another set of new advanced engineered materials to showcase for their effective utilization in infrastructure projects. Please share your constructive feedback and any comments you may have with us.

Best regards and wishing you good health and safety,

Vasant Matsagar
Guest Editor, ICJ