

Editorial

Advanced Concrete Technology and Its Structural Applications

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Concrete is the most widely used building material in the world, and it plays a very important role in building modern infrastructures that stand the test of time. With the ever-increasing demand for higher performance, resilient, sustainable, and smart infrastructures, various advanced concrete technologies have been invented, researched, and implemented at a structural scale.

High performance and smart concrete materials have been designed to possess superior mechanical and functional performance, such as ultrahigh compressive strength [1, 2], high tensile strength and ductility [3–5], high durability [6, 7], self-consolidation [8], light weight [9, 10], impact tolerance [11], fire resistance [12–14], self-healing [15, 16], self-sensing [17, 18], self-cleaning capacities [19], sustainability [20], and/or 3D printability [21, 22]. Research on the application of these structures at structural and infrastructural scale and its performance has been carried out to fully demonstrate the benefits of these advanced concrete technologies.

This special issue provides a collection of research contributions related to advanced concrete technologies and their structural use in civil engineering applications. In this special issue, 19 articles of the 30 submitted manuscripts have been selected and published, among which 6 articles are related to the studies at material scale level and 13 articles mainly focus on the concrete structural performance.

The paper titled with “Flexural Performance of Emulsified-Asphalt-Modified ECC for Expansion Joint Use” is authored by Q. Mao et al. [23]. Based on the application field of transition zone on bridges, they introduced the emulsified asphalt to modify the current engineered cementitious

composites (ECC). It features the increased flexural deformability and reduced modulus upon the addition of emulsified asphalt, which is likely to reduce the impact load on the transition zone caused by vehicle bumping and prolong the service life of the whole bridge expansion joint structure.

A paper by S. Q. Zhang et al. [24] discussed the calculation method of internal curing water amount for the concrete with addition of super absorbent polymer (SAP). The method is derived from Powers’ model for the phase distribution of a hydrating cement paste. The results show that, for the mix designs with fly ash, the entrainment of internal curing water and the dosage of SAP calculated by the method proposed in this paper decreased by 26.6%, compared with the one proposed previously; nevertheless, the compressive strength of concrete increased by 10.8% at 56 days accompanied with a similar autogenously shrinkage.

X. Peng et al. [25] studied the size effects on compressive and tensile strengths of recycled aggregate concrete. According to experimental results, both compressive and tensile strengths of recycled concrete have obvious size effects as the strength value decreases gradually with increased specimen size. They also proposed a standard neutrosophic number for modifying the size effect law on compressive and tensile strengths, which showed that the size effect law based on the neutrosophic number is more realistic than the existing size effect law.

To solve rebar corrosion in existing concrete structures, B. Yi et al. [26] conducted research on inhibiting performance of compound corrosion inhibitors based on nitrite; the results showed that the addition of phosphate can

improve the macrocell corrosion caused by the low dosage or uneven distribution of nitrite, whereas nitrite has a better inhibitory effect than phosphate; additionally, brushing, perfusion, and composite repair can all play a good role in inhibiting corrosion, of which composite repair is the best.

N. Xin et al. [27] conducted a review work in terms of 3D printing in construction: current status, implementation hindrances, and development agenda. The study presented a systematic review of the existing literature from both technical and nontechnical dimensions by combining quantitative and qualitative studies, which is intended to help construction practitioners systematically master existing processes and materials and assess the application degree and necessity of 3DP. Y. Lu et al. [28] discussed the production process, physical and chemical properties, leaching properties, pretreatment methods, and applications of municipal solid waste incineration (MSWI) fly ash and bottom ash. By summarizing the previous literature, it is found that MSWI fly ash and bottom ash have mechanical properties similar to natural aggregate. However, due to concerns about the leaching of heavy metals in fly ash and its side effect, its application in highway engineering is limited. Considering the solidification effect of cement on heavy metals and low cost of fly ash and bottom ash, the application in cement-stabilized macadam base has broad application prospects and is beneficial to reduce construction cost and promote the process of waste incineration, especially in developing countries.

D. S. Chen et al. [29] investigated the mechanical properties of rice husk recycled concrete (RHRC) and employed flexural test on the RHRC sandwich wall. The results showed that the compressive strength of RHRC was reduced with rising rice husk content. In term of structural performance, the RHRC composite sandwich walls have good compression resistance and no instability failure and the flexural capacity of composite sandwich walls is high enough to bear wind load.

In a paper by J. L. Jiang et al. [30], the bending performance of epoxy adhesive prefabricated UHPC-steel composite bridge deck aims to speed up the construction process and avoid risk of cracking caused by UHPC self-shrinkage; in this paper, the positive bending moment loading tests were carried out on the specimens of prefabricated UHPC plates and steel plates with different surface treatments. The test results showed that the interface failure is prior to the yield at the bottom of the steel plate as specimens reached ultimate failure and the rough surface of the steel plate and grooved surface of the prefabricated UHPC plate avail the bending performance.

C. H. Tang et al. [31] investigated the flexural behavior of unbounded prestressed concrete (PC) bridge girders via experimental and numerical methods; the results showed that the flexural destruction behavior in unbonded PC T bridge girders is similar to that of PC T bridge girders and the prestress degree and load location have significant influence on the destruction process in unbonded PC T bridge girders.

Y. Li et al. [32] studied the failure evolution law of the reinforced anchor system under pullout load based on digital

image correlation (DIC); in the anchor system, the pulling force is gradually transferred from the loading end to the free end along the steel bar. Moreover, the failure mode and the ultimate bearing capacity of the anchor system are related to the thickness of the anchor agent.

W. C. Li et al. [33] conducted an experimental study on bond performance between a fiber-reinforced polymer (FRP) bar and unsaturated polyester resin concrete (UPC). It was found that the failure types of FRP bar-UPC specimens depend on the interface bond stress, UPC tensile stress, and stress of the FRP bar; furthermore, the FRP bar-UPC bond strength decreases with the increase of the diameter of the FRP bar due to the shear-lag effect.

A paper by X. Peng et al. [34] proposed a robust estimate method to detect the damage of concrete structures using contaminated data. It was found that this proposed method can successfully identify the location and damage extent of a reinforced concrete beam structure even if the used data have gross errors.

C. Ma et al. [35] analyzed the pure bending vertical deflection of improved composite box girders with corrugated steel webs (CSWs) theoretically. It was found that the shear deformation induced deflection of single-box and single-cell simply supported and two-span continuous composite box girders with corrugated steel webs and steel bottom plates cannot be ignored during calculation and the deflections caused by shear lag and deformation were gradually decreased with the increase in the span width ratio.

A. M. Song et al. [36] investigated the static and fatigue properties of steel concrete composite beams under the hogging moment via experimental tests and analytical models and the structural deformation were also discussed. In the paper, the authors improved the presented models and gained a better agreement with test results; finally, the design recommendations of fatigue deformation were proposed.

X. B. He et al. [37] in the paper titled "Mechanical Properties of Microsteel Fiber Reinforced Concrete and Its Gradient Design in the Partially Reinforced RC Beam" demonstrated that microsteel fiber highly strengthened and toughened the concrete matrix and can significantly diminish the depth of RC beam with the same cracking resistance. Moreover, the authors also proposed a calculation formula of bearing capacity of the partially reinforced beam.

L. Yan et al. [38] carried out the shaking table test on a real bridge model to study the seismic response laws of this kind of bridge under multipoint excitation. The results show that the seismic response of high pier and small-radius curved bridge is affected by different frequency-spectrum seismic waves and the local terrain effect amplifies its seismic response. Based on the results, the authors suggested that the impact of multipoint excitation should be considered in seismic design of high pier with small-radius curved bridge.

T. H. Ma et al. [39] analyzed the overall stability of Xiluodu high arch dam based on fine three-dimension numerical modeling. In the study, the structural design scheme of arch dam and the corresponding foundation treatment design were evaluated. The simulation results showed that comprehensive reinforcement could enhance

overall stability of dam foundation surface under normal load conditions and demonstrated that RFPA3D can provide an effective method for analysis and research of large hydraulic projects in the world.

A paper titled “Fatigue Performance of Reinforced Concrete T-Girders under Cyclic Loading” is authored by J. Q. Zhang et al. [40]. They examined the performance of reinforced concrete T-girders under cyclic loading; it was found that the longitudinal reinforcement fracture is the main cause of T-girder rupture, and during cyclic loading, the concrete cracks, deflections, and strain followed a “three-stage” law. The measured results of the longitudinal rebar stress range are more stable and regular than other mechanical parameters.

Y. Zou et al. [41] studied the static performance of prefabricated UHPC-steel epoxy bonding interface via direct shear test, tensile test, tensile-shear test, and numerical simulation. The results showed that the interface failure was mainly manifested as peeling of the epoxy-UHPC interface and the destruction of part of UHPC matrix (failure of UHPC’s surface). From the stress-displacement curves of interface normal and tangential direction, it could be observed that the curves are all in the shape of a two-fold line and showed brittle failure mode. The numerical simulation concluded that the main failure form of interface failure is a tensile failure.

Conflicts of Interest

The editors declare that there are no conflicts of interest regarding the publication of this special issue.

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