Overview

More than any other time, engineers are facing the challenge of designing, constructing, and preserving the infrastructure system in a sustainable way. Economic prosperity and improved lifestyle are among the benefits of a resilient and sustainable infrastructure system. A resilient system is one that could withstand the extreme effects of a damaging factor and one that could be brought back to functionality in a timely manner. A sustainable system is one that is developed to last long with minimal adverse impact on social, economic, and environmental needs. In civil infrastructures, sustainable materials play a major role in this regard. These could be from renewable resources or materials that are abundantly available, durable, and recyclable.

This special publication of the ASTM's *Journal of Testing and Evaluation* (JTE) contains 26 papers that deal with materials used in sustainable civil infrastructure. The papers have been through rigorous peer review to be published in this special issue of JTE. The materials covered in this publication include asphalt, concrete, soils, and steel. The publication includes both numerical and experimental research and investigation of infrastructure materials. For asphalt, the papers tackle three dimensional discrete element modeling of crack development, intelligent compaction, oscillation testing, and characteristics of asphalt with recycled materials. The topics addressing sustainability in concrete deal with cracking and sustainability of fiber reinforced concrete, seismic behavior of reinforced concrete, cement fracturing, recycled concrete aggregate in drainage systems, polymer concrete, concrete pavements, and roller compacted concrete. In the areas of soils, foundations, and stabilization, there are innovative topics such as caisson behavior during sinking, use of reservoir siltation for backfill applications, bearing capacity application by seismic methods, lime stabilization of expansive soils, fly ash stabilization, properties of unsaturated soils, field versus laboratory stiffness of soils using surface waves, and ground vibration of clay soils. For steel, evaluation of long multi-span girders during incremental launching is presented in the publication. Other topics in the publication include tire-road interaction regarding skid resistance, and the role of infrastructure on emergency medical services.

There are seven papers dealing with material recycling and stabilization. Use of recycled materials in pavements has always been a hot topic. The work by Chen *et al.* was focused on how the volumetric properties and performance of asphalt concrete are influenced by complete replacement of coarse natural aggregates with basic oxygen furnace (BOF) slag, and reported this process as a feasible option. On another front, use of recycled concrete aggregate (RCA) in exfiltration drainage systems such as French drains was investigated by Nam *et al.* The authors concluded RCA No. 4 gradation does not restrict the flow of water, but the RCA fines being generated during aggregate handling process may cause clogging buildup over time. Using fly ash, blast-furnace slag, and silica fume in concrete has been around for many years. Lee *et al.* investigated the effects of steam and microwave curing on concrete containing these recycling materials. The microwave-cured concrete did not show an increase in permeability relative to the concrete that was steam-cured, but showed an increase in strength. The effect of lime and the curing period on the compressibility and durability characteristics of expansive

semiarid soils was evaluated by Moghal *et al.* using a range of loading periods of time, concluding that lime significantly reduces the compressibility, and that increase in duration of loading time produces a moderate increase in the final void ratio values, and finally a considerable decrease in the concentration of calcium is observed with increasing the curing period. Factors limiting the application of some fly ash in stabilization of soils and roadbed materials are addressed by Mráz *et al.* Specifically, the researchers indicated that the limitations in usage in some cases are related to the relatively low resistance in repetitive contact with water, volumetric changes and the risk of partly unsatisfactory hygienic and environmental impact. Techniques to reduce these negative impacts are suggested by the authors. Treatment of fibrous peat, which is extremely soft with high moisture content, is studied by Kazemian *et al.* Experimental work with special type of binder indicated proper cementing and stabilization of peat. Finally, massive reservoir siltations (RS) have seriously disrupted the service of many reservoirs worldwide, with adverse effects on infrastructure sustainability. Wu and Lin propose a novel approach using RS to produce controlled low strength materials, reinforced with geobags, for storage and backfill applications.

Asphalt related topics are discussed in three papers. Cracking in epoxy asphalt concrete (EAC) used for steel bridge wearing course has always been a major cause of structural and functional deterioration of this material, particularly in cold climate. Qian *et al.* developed a three-dimensional (3-D) fracture model using a randomly generating algorithm to investigate the fracture behavior of EAC. Intelligent compaction of asphalt concrete has been gaining considerable momentum within the last decade. In the paper by Singh *et al.*, a procedure for estimation of effective modulus of a multilayered HMA pavement using Intelligent Compaction (IC) was investigated. Finally, in characterization of asphalt concrete behavior, assumptions are often made regarding the magnitude of material's Poisson's ratio disregarding the impact of loading time on this important property. Zak *et al.* used small amplitude sine load tests as well as relaxation tests to demonstrate how the Poisson's ratio changes as a function of time.

Concrete and cement are discussed in four papers. Highly flowable, strain-hardening fiber-reinforced concrete has good workability in the fresh state and high-performance in the hardened state. Through mechanical testing, Liao and Chao demonstrated that this type of concrete also presents a lower crack potential and excellent crack width control. Investigating fracture in roller compacted concrete (RCC) is the subject of investigation by Cui *et al.* The authors researched two groups of RCC specimens and determined double-K fracture parameters. It was indicated that the unstable fracture toughness increases and initial fracture toughness decreases when the crack depth ratio is increased. Yao *et al.* studied the mix proportion and mechanical properties of polyethylene terephthalate (PET) concrete using an orthogonal test. Influence of various factors was considered, and it was found that the ratio of PET/mineral aggregate had the largest impact on compressive strength. Finally, Ge *et al.* studied the behavior of concrete columns reinforced with high strength hot rolled bars of fine grains, and concluded satisfactory performance of such columns.

There are three papers regarding bearing capacity and soil characterization. Caisson is often used as the foundation of important structures, and its sinking process affects is performance. Zhao *et al.* carried numerical simulation as well as laboratory experiments to study the macro- and meso-scale mechanical behaviors of the caisson during sinking, providing tools for better understanding of the earth pressure on caissons. The challenge of determining the soil bearing capacity under a constructed building is tackled by Xu *et al.* using the Rayleigh wave method. Rayleigh wave velocity measurements and static load capacity were measured for several different kinds of soil, resulting in a fitting formula between shear wave velocity and soil bearing capacity under specific soil conditions. Finally, Wang *et al.* take advantage of several technologies including scanning electron microscope, energy dispersive spectrometer, digital image processing, and triaxial testing to characterize microstructure and unsaturated properties of special types of clay.

Construction challenges are topics of discussion in three papers. The challenge with construction of two bored tunnels passing underneath an existing high speed rail is presented by Ni and Cheng. The authors discuss the challenges associated with long distance horizontal wash boring through diaphragm walls, scattered with steel H-beams and accompanying grouting strategy. The experimental work undertaken by Busch *et al.* indicates the ground response of clay soils in confined conditions subjected to explosive airblast loading. Results of the study included surface crater geometry measurements, ground vibration data and air overpressure data. The experiment results provided a data set that could be used to predict the effects of airblast loads on clay soils. Finally, the structural performance of steel U-shaped girder during launching construction is the subject of investigation by Wang *et al.* The geometric configuration of the steel U-shaped girder was analyzed and a method was proposed to determine the girder behavior based on a comprehensive finite element analysis of local stress characteristics as well as experimental investigation.

Seismic response of materials is discussed in three papers. Vibration response of multilayered pavement system is studied by Yao *et al.* through a laboratory experimental exercise. The authors indicate how the use of geotextile interlayers reduced vibration displacement in the system. The interlayer has the effects of damping vibration and resisting water erosion of the pavement base. Dai *et al.* demonstrate the steps that one can take in conducting surface wave surveys for both small and large medium applications, and provide two specific examples at both ends of the size spectrum. The last paper of this group regards correlating the laboratory produced engineering properties of materials to the in-situ values, as it has always been a difficult task. Martins and Gomes present their approach in establishing a relationship between field and laboratory moduli based on spectral analysis of surface waves for clayey sand.

Three papers present some of the issues and concerns regarding pavements and transportation. A major factor in highway safety is the friction between the road surface and the trafficking tires. Chen exhibits a systematic framework to predict skid resistance of wet pavement with non-contact method in real time. Yang *et al.* discuss an emerging method, radio frequency identification (RFID) technology, for locating manholes beneath

the pavements. Through the program developed by the authors, the time and costs of manhole identification can be significantly decreased. Finally, the effectiveness of emergency medical services (EMS) depends on the existing infrastructure and allocation of medical resources. Chen *et al.* assessed the effect of service area of EMS after a disaster on the transportation infrastructure, and proposed an approach for conducting such an assessment.

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Guest Editors