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Editorial

Geomaterials for Transportation Infrastructures

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The American Society of Civil Engineers' (ASCE) quadrennial report card exhibited the grim picture of nation's transportation infrastructure. Road infrastructure obtained "D" grade (poor condition) in a recently released infrastructure [1]. The highest grade of this specific category is "C+" in the last 23 years of record. While the road infrastructure is in crumbling condition, using innovative geomaterials is one of the means to improve the current status.

Transportation infrastructure costs a tremendous amount of money, time, and labor to build and maintain. Transportation geomaterials serve as the foundation to build sustainable roadways, railways, airfields and ports, embankments, tunnels, and so on. The geotechnical properties of the multi-layers, structures, and foundations are the prerequisite to the quality, service life, and maintenance of transportation infrastructures. Soil, aggregates, concrete, asphaltic materials, and steel are the major materials in transportation. Although aggregate is cheaper than many other engineering materials, it has a huge cost impact, as it is used in a bulk amount.

Aggregates account for 80 to 85% by volume of typical asphalt concrete, and 62 to 68% by volume of cement concrete. In 2012, approximately 1.3 billion tons of crushed stone, worth approximately USD 12 billion, were produced in the United States. Of the total crushed stone, 82% was used as a construction material, mainly for road construction and maintenance. For sand and gravel, approximately 927 million tons, worth about USD 6.4 billion, were produced, of which 26% was used for road base, coverings, and road stabilization, and 12% was used as asphalt concrete aggregates and in other asphalt-aggregate products [2]. About 130 million barrels (23 million tons) of asphalt binder and road oil was used in the United States in 2011, which cost USD 7.7 billion [3]. The value of asphalt paving mixtures produced in the United States was estimated at USD 11.5 billion in 2007 [4]. The United States used approximately 111 million tons of hydraulic cement in 2005, worth about USD 9.1 billion, according to the United States Geological Survey. Approximately 5% of cement used in the United States in 2011 was used for road paving purposes [5]. Approximately 8 million tons of reinforcing steel (rebar) is manufactured per year in the United States, using the scrap steel in efficient manufacturing operations.

Despite the huge cost, transportation infrastructure materials undergo continuous rapid degradation due to the increasing traffic and harsh climate. To this end, the need for a cost-effective and sustainable transportation foundation is an immense need and more essential than ever for transportation infrastructures. The future development of transportation infrastructure tends to be larger, longer, smarter, and eco-friendlier, which brings new challenges to transportation geomaterials. New research topics have been brought forward by the development and evolution of transportation geomaterials, where more and more attention is being paid to the integration of emerging technologies, such as big data, artificial intelligence, and smart materials, and into transportation geomaterials.

This Special Issue published five original research on the latest developments and challenges in the field of transportation geomaterials, which will ensure cost-effective, eco-friendly, and sustainable transportation infrastructures. Khan et al. [6] investigated the effectiveness of recycled plastic pins (RPPs) in slopes constructed with high plastic clay soil (CH), using the finite element method (FEM). The FEM analysis was performed using the PLAXIS 2D software. The FEM analysis results indicated that RPP provides better shear resistance for the sloping embankment constructed on high plastic clay. Uniform spacing of RPP provided sufficient resistance that increased the factor of safety (FS) to 1.68 in 2H:1V slopes with less than 15 mm deformation. The uniform spacing and varied spacing combination of RPP increased the FS to 2.0 with the deformation of RPP less than 7 mm. Babatunde et al. [7] evaluated the effect of elapsed time on the strength of lime and iron ore tailings (IOT)-treated black cotton soil (BCS), an expansive tropical black clay as road construction material. BCS was treated with 0, 2, 4, 6, and 8% of lime and 0, 2, 4, 6, 8, and 10% of IOT content by the dry weight of the soil. The study showed that the strength (i.e., UCS and CBR values) increased with an increase in lime/IOT contents between 0 and 2 h after mixing. Peak strength values were recorded for 8% lime/8% IOT treatment for all lime content considered. A strong relationship between the strength properties and the soil parameters was observed. An optimal 8% lime/8% IOT treatment of BCS for elapsed time after mixing not exceeding 2 h was established and was recommended as sub-base material for low-trafficked roads. This recommendation would save a huge road construction cost for rural areas. Imtiaz et al. [8] studied the quantity of micropores and their effect on the strength of recycled materials used as the basis of microstructural analysis of recycled concrete and reclaimed asphalt. Microstructural properties obtained from analyzing scanning electron microscope (SEM) images were correlated with unconfined compressive strength data. Intra-aggregate and inter-aggregate pores were studied for different ratios of cement-treated mixture of recycled asphalt pavement (RAP) and recycled cement concrete aggregate (RCCA). The results showed that the addition of RAP considerably increased the number of pores in the mixture, which eventually caused a reduction in unconfined compressive strength. In addition, significant morphological and textural changes in recycled aggregates were observed by SEM image analysis. Therefore, proper mix design is recommended before using an excessive amount of RAP. The study by Wright et al. [9] aimed to determine the difference in the post-trafficked strength and stiffness of pavement foundation. A dynamic cone penetrometer and light weight deflectometer were utilized to determine material changes from this trafficking and revealed that all specimens that included a geosynthetic layer had a higher base stiffness and strength, while the specimen with geotextile and geogrid in combination created the greatest stiffness and strength after large-scale rolling wheel trafficking. The study by Putra et al. [10] discussed the potential increase in the strength and stiffness of the soil, the additional materials for grouting, the effect of these materials on the treatment process, and the mechanical properties of the soil. The possible sources of the urease enzyme and the applicability of the EICP method to other soil types were also discussed. The environmental and economic impacts of the application of EICP were also presented. In addition, the envisioned plans for application, potential advantages, and demerits of EICP for soil stabilization were discussed. Finally, the primary challenges and opportunities for development in future research were also briefly addressed.

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