Monday 3/13/2017

2–3:30 p.m.

Life Cycle Assessment & Sustainable Engineering

Chairs: Krishna Reddy, University of Illinois at Chicago; Kristi Bumpas, Red Rock Consulting

Sustainability Assessment of Conventional and Alternate Landfill Cover Systems

Marat Goldenberg, Burns & McDonnell Engineering Co.; Krishna Reddy, University of Illinois at Chicago

A conventional landfill cover system composed of a geomembrane and low permeability soil is the typical minimum requirement for landfill covers as required by the Resource Conservation and Recovery Act (RCRA). More recently, alternate cover systems have been used to reduce costs and still meet the regulatory objectives. Evapotranspiration (ET) cover systems have gained popularity over the years due to their low cost and ability to meet the performance objectives when designed properly. The purpose of this paper is to evaluate alternate landfill cover systems and to provide a sustainability assessment by evaluating the carbon footprint and the life cycle assessments of three commonly used landfill covers. The findings suggest that while an ET cover system is the most sustainable alternative in most cases, hauling soils greater distances can result in an ET cover being less sustainable and likely costlier due to the increased transportation.

Life-Cycle Carbon, Energy, and Cost Analysis of Utilizing Municipal Solid Waste Bottom Ash and Recycled Asphalt Shingle in Hot-Mix Asphalt

Behnam Golestani, Professional Service Industries Inc.; Boo Hyun Nam,Tolga Ercan, and Omer Tatari, University of Central Florida;

The demands for pollution-free and recyclable engineering materials have increased as energy cost and environmental concern have risen. Moving toward green materials and design are approaches for better environmental quality and sustainable civil infrastructures. Pavement construction is one of the largest consumers of raw materials. Beneficial utilization of recycled materials in the pavement can result in an extraordinary opportunity to save mining, natural resources, energy, and landfill spaces. This study evaluates the structural and environmental-economical benefit performance of hot mix asphalt (HMA) by substituting virgin materials with one or a combination of two recycled materials. The two used recycled materials are recycled asphalt shingle (RAS) and municipal solid waste incineration bottom ash (MSWI-BA). This research introduces a sustainable HMA that potentially reduces the necessity of virgin fine aggregate and asphalt binder to 20% and 19%, respectively. In terms of environmental and economic impacts, in comparison with the regular HMA, it generates 15.5% less greenhouse gas emission, and for a period of 20 years, the cost of construction and maintenance would be 46% less.

Life Cycle Assessment of Ground Improvement Alternatives for Treasure Island, California Redevelopment

Alena J Raymond, Alissa Kendall, and Jason DeJong, University of California, Davis; Mark Pinske, McMillen Jacobs Associates

This study evaluates the environmental and economic impacts of five ground improvement methods for the possible redevelopment of Treasure Island in San Francisco, California. Each method is required to meet a deterministic performance criterion to minimize susceptibility to liquefaction triggering, defined as a normalized Standard Penetration Test (SPT) blow count of 15 or greater. For each improvement method, the study quantifies the resources and emissions flows over the entire life cycle from raw material extraction through the end of construction operations and evaluates the primary energy, global warming potential, acidification potential, smog formation potential, raw project cost, and social cost of carbon. Sensitivity analysis was performed to evaluate assumptions regarding materials selection and transport distances, and a scenario analysis was conducted to compare multiple improvement scenarios for the Treasure Island redevelopment project. The study concludes that the most environmentally preferable combination of improvement methods does not include deep soil mixing.

Life-Cycle Modeling of Municipal Solid Waste Landfills

Morton Barlaz and James W. Levis, North Carolina State University

Landfills that receive municipal solid waste represent a critical component of solid waste infrastructure in the U.S. and are a leading source of greenhouse gas emissions. Thus, it is critical to understand the factors that control the environmental performance of landfills. Life-cycle modeling of landfills is complex, as landfills constantly change over time. The objective of this research was to develop a life-cycle model of an average ton of municipal solid waste disposed in a “national average” landfill. The framework considers critical factors relating to the temporal changes in landfill gas generation, collection, beneficial use, and oxidation. The model calculates temporally averaged landfill gas collection efficiencies for individual waste components in consideration of the aforementioned factors. The results indicate that for mixed waste, 12 to 41% of the generated methane becomes fugitive emissions. The results also show the significant potential benefits of earlier landfill gas collection.

Evaluation of Mitigation Techniques for Expansive Behavior of Steel Slag

Asli Yalcin Dayioglu, Istanbul Technical University; Ahmet H. Aydilek, University of Maryland

Steel slag, a byproduct of steel industry and approximately 15% of original steel input, has favorable engineering properties. However, the tendency of the material to expand due to free lime and magnesia within the elemental composition impedes its use in highways, where large volumes of the slag can be utilized, hence a pretreatment is required. For this purpose, water treatment residual (WTR), an aluminum rich by-product of drinking water plants, and a sandy borrow material provided by Maryland State Highway Administration are used as dry mixing additives by different percentages. In order to evaluate the swelling behavior of three steel slag materials with different aging properties upon the two treatment techniques, accelerated swell tests (ASTM D-4792) are performed. The results indicate that both treatment methods decrease the ultimate swelling ratio significantly. Using treated steel slag in highways results in reduction in waste disposal costs and in consumption of natural resources.

Use of Jute as a Sustainable Alternative for PP in Geotextile Tubes

Zeru Kiffle, Samantha Steele, and Shobha K. Bhatia, Syracuse University; Jennifer L. Smith, John P. Stopen Engineering LLP

Geotextile tubes have been used extensively to contain and dewater high water content materials. Geotextile tubes are typically manufactured from polypropylene (PP), a high embodied energy polymer, because of their relatively high tensile and seam strength properties that are often necessary to withstand the stresses that can develop in a geotextile tube during filling, and to maintain geotextile tube shape after filling. There are applications where lower-strength jute geotextiles could be used to manufacture smaller, more sustainable geotextile tubes for use in sensitive environmental applications, such as in wetland or shoreline rehabilitation applications. This paper presents the results of a laboratory study that compares the filtration performance of PP versus jute geotextiles for use as geotextile tubes, demonstrating the potential use of jute in geotextile tubes. Second, the paper presents a life cycle analysis that compares commercially available PP geotextile tubes to jute geotextile tubes. Overall, jute shows great promise for use in geotextile tubes.