QUARTERLY PROGRESS REPORT

December 1, 2016 to February 28, 2017

PROJECT TITLE: Use of Solid Wastes in Asphalt and Concrete

PRINCIPAL INVESTIGATOR(S): Timothy G. Townsend

AFFILIATION: Professor, University of Florida
Department of Environmental Engineering Sciences

CO-PRINCIPAL INVESTIGATOR(S): Christopher C. Ferraro

AFFILIATION: Research Assistant Professor, University of Florida
Department of Civil and Coastal Engineering

COMPLETION DATE: May 31, 2017 **PHONE NUMBER: 352-392-0846**

PROJECT WEBSITE: https://www.essie.ufl.edu/home/townsend/research/bu/hc15/

Work accomplished during this reporting period:

The UF research team performed an additional test on the waste-to-energy (WTE) ash-derived aggregates collected in the last reporting period, the Los Angeles (LA) Abrasion Test (FM 1-T096). This test method observes how well the ash aggregate resists degradation due to impact mechanisms, which simulates the transport of this material in aggregate stockyards and batch processing plants. These ash aggregates met the maximum loss limit prescribed by the Florida Department of Transportation (FDOT) of 45% and ranged from between 36-42%.

The concrete specimens made with varying replacements of WTE combined ash were tested at 7, 28, and 56 days using ASTM C39, Standard Test Method for Compressive Strength of Cylindrical Concrete Specimens. These concrete specimens were also tested at 28 days for ASTM C469, Standard Test Method for Static Modulus of Elasticity and Poisson's Ratio of Concrete in Compression, and ASTM C496, Standard Test Method for Splitting Tensile Strength of Cylindrical Concrete Specimens. Overall, these tests showed that with increasing replacement of WTE ash the strength of the concrete decreased but could still meet minimum FDOT strength requirements at lower percentages based on FDOT Road & Bridge Specifications Section 346 Portland Cement Concrete.

The mortar bars made using two bottom ash aggregates and one combined ash aggregate were created and tested according to ASTM C1260, Standard Test Method for Potential Alkali Reactivity of Aggregates (Mortar-Bar Method) and ASTM C1567, Standard Test Method for Determining the Potential Alkali-Silica Reactivity of Combinations of Cementitious Materials and Aggregate (Accelerated Mortar-Bar Method). This involved making ten mixes for ASTM C1260 testing and six mixes for ASTM C1567 testing. The ASTM C1260 mixes varied the facility source and replacement percentages (i.e., 0, 15, 30, and 50%) of WTE ash, while the

ASTM C1567 mixes maintained a constant 30% WTE ash replacement from the three different facility sources but used either 20% fly ash or 20% ground glass as a cementitious material replacement instead of portland cement. These results showed that the addition of WTE ash, even at 15%, may cause deleterious expansion in concrete specimens. However, the addition of other cementitious materials (i.e., fly ash and ground glass) at 20% allowed for a 30% replacement of WTE ash with no observed deleterious expansion.

Superpave asphalt mix designs were finalized for the two bottom ash and one combined ash aggregates (1/4"-3/4"). These ashes replaced coarse aggregate at 15%, by mass, for each mix. Volumetrics, a crucial part of the mix design process, were determined by performing FM 1-T209, Florida Method of Test for Maximum Specific Gravity of Asphalt Paving Mixtures, and FM 1-T166, Florida Method of Test for Bulk Specific Gravity of Compacted Asphalt Specimens. Determining the maximum and bulk specific gravities for an asphalt concrete mixture provides information on the air voids, voids in mineral aggregate (VMA), and voids filled with asphalt (VFA) which are used to verify a Superpave mix design. These mixes met most of the required volumetrics except for VMA, which was slightly below the minimum allowed. To investigate this issue, a literature review was conducted which identified low VMA as a relatively common problem even for asphalt mixes using traditional aggregates.

Another concern that was identified in the literature regarding the reuse of WTE ash in asphalt pavement was rutting susceptibility, or the durability of asphalt pavement with repeated vehicle loading over time. The UF research team tested the combined ash-amended asphalt specimens using the Asphalt Pavement Analyzer (APA) rutting test. This test (AASHTO TP63) involves subjecting two asphalt specimens to 140°F and having a loaded wheel device roll over them repeatedly for 8,000 cycles. The results from this test showed that the asphalt specimens rutted far less than the FDOT maximum limit (up to 4.5 mm deformation allowed) and was comparable to other Florida asphalt specimens using traditional aggregates (e.g., limestone) from around the state.

During this reporting period, environmental testing was also started on ash-amended asphalt specimens. This involved performing EPA Method 1315, Mass Transfer Rates of Constituents in Monolithic or Compacted Granular Materials Using a Semi-Dynamic Tank Leaching Procedure, on prepared asphalt specimens in duplicate. This method measures the cumulative mass release of constituents of potential concern (COPC) over a 63-day period by sampling and replacing reagent water at predetermined time intervals. This testing will extend into the next reporting period, at which point the results will be compiled and analyzed.

Work planned for the next reporting period:

In the next reporting period, a new test will be developed to more accurately reflect how water leaches from asphalt pavement under in-service conditions (i.e., infiltration). Additionally, other environmental tests of ash-amended asphalt concrete will continue (i.e., EPA Method 1315 – monolith) and be initiated (i.e., EPA Method 1312 – Synthetic Precipitation Leaching Procedure). The results from these tests will be evaluated and compared to one another to determine what COPC are present, if any.

Metrics:

Graduate Students

Name	Rank	Department	Professor	Institution
Kyle Clavier	Master's Student	Environmental Engineering	Timothy Townsend	University of Florida
Fernando Oliveira	Master's Student	Environmental Engineering	Timothy Townsend	University of Florida
Linda Monroy Sarmiento	PhD Student	Environmental Engineering	Timothy Townsend	University of Florida
Matthew Schafer	Master's Student	Environmental Engineering	Timothy Townsend	University of Florida
Chad Spreadbury	PhD Student	Environmental Engineering	Timothy Townsend	University of Florida
Stephen Townsend	Master's Student	Environmental Engineering	Timothy Townsend	University of Florida

Undergraduate Students

Name	Rank	Department	Professor	Institution
Sara Fox	Undergraduate Research Assistant	Environmental Engineering	Timothy Townsend	University of Florida
Edward Galvan	Undergraduate Research Assistant	Environmental Engineering	Timothy Townsend	University of Florida
Jarrod Petrohvich	Undergraduate Research Assistant	Environmental Engineering	Timothy Townsend	University of Florida

TAG Meetings:

No Technical Awareness Group (TAG) meetings were held during this period.