Leaching Characteristics of Asphalt Road Waste

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Timothy G. Townsend, Principal Investigator
Allan Brantley
University of Florida

State University System of Florida
FLORIDA CENTER
FOR SOLID AND HAZARDOUS WASTE MANAGEMENT
2207 NW 13th Street, Suite D
Gainesville, FL 32609

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Timothy G. Townsend, Principal Investigator
Allan Brantley, Graduate Research Assistant
Department of Environmental Engineering Sciences
University of Florida
Gainesville, FL 326 1 l-6450
(352) 392-0846

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ABSTRACT

The construction and expansion of asphalt roadways result in the production of a large amount of asphalt road waste also known as reclaimed asphalt pavement (RAP). A major fraction of this RAP is recycled by incorporation into a new asphalt mixture. However, some of this material may remain as a solid waste and require disposal or reuse in some other form. One proposed alternative for the management of RAP is in the use as fill material, in applications such as embankments or construction fill. One limitation to using RAP as fill material stems from the unknown risks of pollutants leaching f?om the waste to the environment.

Data regarding the composition of leachate from RAP is limited. It has been suggested that chemical compounds such as polycyclic aromatic hydrocarbons (PAHs) and heavy metals might be present in RAP and therefore leach Erom RAP. This might occur as a result of the chemical composition of asphalt and from contamination occurring from vehicle traffic on the roadway. An investigation was performed to address concerns associated with leaching of chemicals from RAP under simulated environmental conditions. Such an investigation also provides valuable information regarding possible environmental impacts associated with leaching of pollutants from large stockpiles of RAP.

A series of leaching tests were performed at both batch-scale and in leaching columns. This study focused on leachable pollutants and did not attempt to characterize the total concentration of pollutants in the MI?. The primary chemicals investigated were volatile organic compounds (VOCs), polycyclic aromatic hydrocarbons (PAHs), and heavy metals. The results of the TCLP tests performed indicated that the IQ4P tested was not a hazardous waste. None of the compounds analyzed for were detected in the SPLP leachate. Based on existing waste management policy in Florida, the SPLP results indicated that IMP of the nature tested in this study would result in exceedances of groundwater guidance concentrations for the pollutants studied. In the column study, lead was detected in amounts slightly above the groundwater guidance concentration but decreased over time. One unsaturated column and three saturated columns (two sites) exceeded the 15 ppb groundwater guidance concentration. AI1 but one column dropped to below 1 ppb by the end of the study.

The differences in lead concentrations observed in the batch study and column study were a result of the much greater solid-to-liquid ratio in the columns. It is standard practice to apply a dilution factor to actual leaehate concentrations such as those from column tests (dilution is assumed to already occur in batch tests). Using typical dilution factors for land-applied waste, even the greatest concentration of lead measured in the leachate would be lower than the groundwater guidance concentration. Lead was observed at the greatest concentrations in the oldest RAP samples. This indicated that the lead was not a result of the aggregate or asphalt cement, but rather a result of vehicle traffic and emissions. The results of this research project indicated that IUP of the nature examined in this study poses minimal risk to groundwater as a result of pollutant leaching under normal land disposal or beneficial reuse scenarios. Conditions of possible concern would be M1? used in saturated environments where little dilution occurred.

EXECUTIVE SUMMARY

OBJECTIVES

Approximately 2.5 million miles of paved roads currently exist in the United States **(NAPA,** 1997). Due to daily wear and tear, roadway expansion, and construction related activities, these roadways sometimes need to be removed or repaired. During reconstruction or removal of a road surface, reclaimed asphalt pavement (RAP) is commonly obtained by milling or removing the existing pavement. RAP is typically recycled back into new hot mix asphalt, but in some instances all of it can not be reused. A proposed alternative for the management of RAP is use as fill material. One limitation to using RAP as fill material stems Tom a lack of knowledge regarding possible environmental impacts of Ml?

Two different types of environmental concerns relate to leaching of pollutants from RAP. The first is the leachate produced when rainfall infiltrates RAP stockpiles. These RAP stockpiles can range in size up to 2000 yd3. Concerns have been expressed that the leachate produced could potentially be contaminated with trace amounts of hazardous chemicals, namely organic compounds or heavy metals. These chemicals could be the result of accidental spills onto the roadway from vehicles or possibly due to the virgin material used to make asphalt. **A** second environmental concern is the use of IUP as fill material. IMP used as fill material could potentially leach off contaminants when rainftil infiltrates the waste (an unsaturated condition). In some instances the RAP may be proposed to be used as fill below the water table (a saturated condition). In both situations, the leachate produced could potentially be contaminated with trace amounts of hazardous chemicals, such as organic compounds and heavy metals.

This project was conducted to address some of the environmental concerns expressed by regulators and others related to the leaching of pollutants from asphalt road waste, primarily RAP. **A** series of leaching tests were performed at both batch-scale and in leaching columns. The primary chemicals investigated were volatile organic compounds (VOCs), polycyclic aromatic hydrocarbons (PAHs), and heavy metals. While it is generally recognized that RAP does not present a great risk to human health or the environment, a better characterization of the amount and type of chemicals that leach in the environment helps provide a better means to correctly manage this material.

ORGANIZATION OF REPORT

This research report is organized as follows: Chapter one provides a brief overview of the issues surrounding FM? and its potential environmental impacts. Chapter two reviews the relevant literature pertaining to asphalt road waste and its impact on the environment. This chapter also gives a background of different asphalt materials. Chapter three presents the experimental methodology for the study. Chapter four presents and discusses the results of the leaching studies. The final chapter discusses the results and provides conclusions.

METHODOLOGY

In light of the environmental concerns about RAP, a project involving a series of leaching tests was performed at the University of Florida Solid and Hazardous Waste Laboratory. The first step included collection of six RAP samples throughout the state of Florida. After sample collection, the FDOT bituminous laboratory physically characterized the RAP samples. Then a series of leaching tests were performed on the RAP samples. The first tests were typical batch-leaching tests including the TCLP, SPLP, and DI leaching procedure. The second test was a column leaching test performed to simulate a more realistic environmental condition. Leachate samples obtained fkom the batch experiments and column experiments were analyzed for the same parameters. The primary chemicals investigated were volatile organic compounds (VOCs), polycyclic aromatic hydrocarbons (PAHs), and heavy metals. The total concentrations of pollutants in the RAP were not measured.

RESULTS AND DISCUSSION

Batch tests were pefiormed on all six RAP samples. In the leachate generated during the TCLP batch test, measurements of volatile organic compounds (VOCs), polycyclic aromatic hydrocarbons (PA&Is), and heavy metals all were below detection limit (BDL) and below any applicable TCLP limits. The IUP samples evaluated were therefore not a hazardous waste. This result was expected, as the literature had demonstrated this.

Batch tests are also used by regulatory agencies to determine whether a waste presents a potential leaching threat to groundwater. Concentrations of pollutants from batch tests are usually compared directly to groundwater limits or guidance concentrations. TCLP test are sometimes used. The literature did present some TCLP results that were above applicable groundwater limits for some heavy metals (Kriech 1990,1991,1992). The TCLP test is a somewhat aggressive test that represents the conditions inside an anaerobic landfill. Less aggressive tests were therefore also conducted in this study (SPLP and deionized water). The SPLP is currently the method of choice for evaluating leaching from waste or contaminated soils in Florida when exposed to rainfall.

In all of the batch tests, measurements of VOCs, PAHs, and selected heavy metals (Ba, Ca, Cr, Cu, Pb, Ni, and Zn) all were below detection limit (BDL) and were below applicable regulatory groundwater guidance concentrations. This indicated that the IUP samples tested did not pose an undue risk (in regard to leaching of the pollutants tested) under current waste policy in Florida. No comparisons can be made regarding the effectiveness of each test to leach pollutants because no pollutants were measured.

Column (lysimeter) tests were then performed on the same six RAP samples. Column tests are not a prescribed test procedure by reguIatory agencies. They were conducted in this case to investigate leachate production from RAP under more realistic environmental scenarios. Approximately 60 lbs of RAP material filled a three foot section of each column. Duplicate columns were subjected to saturated and unsaturated conditions. Column leachate samples were analyzed for the same parameters as the batch tests and continued for a total of 42 days. The columns did leach large concentrations of ions such as calcium, sodium, sulfate,

fluoride, and carbonate as a result of mineral leaching from the aggregate used in the asphalt pavement manufacture. All VOC and PAH analytical results were similar to the batch test -- no compounds were detected. Leachate concentrations for selected heavy metals (Ba, Ca, Cr, CU, Ni, and Zn) were always below detection limits (BDL). An exception was lead (Pb), which was detected.

Only one unsaturated lysimeter resulted in a leachate with a lead concentration above the groundwater guidance concentration (15 ppb). Leachate from the unsaturated lysimeter containing the Jacksonville sample had a lead concentration of approximately 24 ppb twelve days into the sampling period. The concentration of lead decreased over time and then leveled off well below the regulatory guidance concentrations. In the saturated columns, all columns had detectable concentrations of lead ranging from 5 ppb to 38 ppb. Three out of the six lysimeters (two sites) were above the regulatory guideline. The lysimeters decreased over time to lead concentrations below the guidance concentration (and the detection limit) except the Jacksonville sample. The Jacksonville sample concentration decreased slightly but was still above the guidance concentration at approximately 18 ppb.

The batch tests were more dilute than the column tests. This condition helps to explain why lead concentrations were observed in the column study but not in the batch test. In a real world situation, rainfall would ultimately dilute leachate produced corn a stockpile before it reached the groundwater table or a nearby receiving body of water. This phenomenon is commonly referred to as dilution-attenuation. Attenuation models, used to determine the concentration of a pollutant in the groundwater resulting from waste piles and landfills, commonly use a dilution factor of 20 in their models. This dilution factor is accounted for in the batch test by the 20 to 1 liquid to solid ratio. In the column study, somewhat no dilution is involved. If the concentrations produced from the column studies were used as part of a groundwater dilution model, results would likely be below any regulatory guideline.

Lead was observed in the greatest concentrations in the oldest IMP samples. This indicated that the lead was not a result of the aggregate or asphalt cement, but rather a result of vehicle traffic and emissions. Lead has been used for many years in leaded gasoline and in crankcase oil. Since vehicle accidents and accidental spills contribute to this contamination, there is a possibility that this contamination was site specific. Previous studies regarding asphalt road waste also found trace amounts of lead in some circumstances. Since lead was encountered in greater concentrations in older samples, the source of lead was likely prolonged exposure to vehicle traffic and emissions. Under most reuse circumstances, even if lead were encountered at levels of the highest concentration measured in this study, the concentrations in the environment would be below acceptable regulatory levels for drinking water. Possible exceptions would be older IMP placed below the water table in areas with little or no dilution.

Most of the previous studies regarding RAP leaching were consistent with the results found in this study. Organic compounds do not leach from typical RAP under the conditions tested. Heavy metals are sometimes encountered. The literature indicated the presence of

chromium, lead, and barium. Only lead was detected in this study and was ascribed to prolonged exposure to and vehicle emissions. The literature often referred to chromium resulting from slag used as aggregate. It should be noted that the aggregate used in the asphalt samples collected for this study was assumed to be natural aggregate (e.g. limerock). If other materials -- especially waste materials such as slag, spent sandblast grit and ash -- are used as aggregate, the results gathered here may not be applicable. It should also be noted that fresh asphalt was not tested, nor were extremes in temperatures evaluated.