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New Jersey Department of Transportation
Bureau of Research

Technical Brief

The New Jersey Department of Transportation allows the use of Reclaimed Asphalt Pavement (RAP) materials in bound Hot Mix Asphalt (HMA) applications. The use of RAP; however, in unbound applications is limited due to concerns of pollutants leaching out of it when used in unbound applications (e.g., under guiderails, surface aggregates for parking lots, etc.) This study aimed at evaluating the environmental impacts of RAP and determining whether its use in unbound applications has negative impacts on the environment.

Background

Reclaimed asphalt pavement (RAP) is obtained through milling and removal of existing pavement surfaces. RAP materials have been successfully reused and recycled into new asphalt pavements since the 1970s. Despite the benefits of recycling RAP materials, not all of it can be recycled into new asphalt pavements. Therefore, the unused RAP materials have to be either stored on site for long periods of time or disposed of in waste landfills; which is often costly. RAP materials have been used as aggregates for unbound base materials, aggregates for stabilized base materials, pothole filler materials, and roadway shoulder materials. However, New Jersey (NJ) RAP usage in these applications (i.e., in unbound engineering applications) has been restricted due to environmental concerns from the possibility of potential toxic pollutants that might leach out of it.

To address these concerns in NJ, a research study was initiated with the goal of investigating the environmental impacts of unbound reclaimed asphalt pavement (RAP) while it is freshly processed (i.e., when it is obtained directly after mixing from the plant) and after subjecting it to an accelerated weathering process. The secondary goal was to explore potential engineering solutions to meet federal and state environmental standards or guidelines. To accomplish these goals, three RAP materials were obtained from asphalt plants throughout NJ. In addition, one of the plants provided a fresh Hot Mix Asphalt (HMA) loose mix samples to serve as a fresh asphalt sample (i.e., not aged or contaminated) for comparison. These materials are denoted thereafter as: NORTHRAP, CENTRALRAP, SOUTHRAP, and FRESH (containing 0 percent RAP). Materials from all RAP sources and HMA underwent four different types of weathering processes including: ultra violet (UV) and precipitation weathering on unbounded RAP, UV and precipitation weathering on compacted RAP, weathering by heat and moisture cycles, and groundwater flow-through leaching. Batch experiments were conducted to mimic leaching of pollutants from landfills. Two-column experiments (a RAP column followed by a soil column) were conducted to investigate the release of metals and PAHs from RAP samples and the attenuation effect of soils on these potential pollutants. Finally, RAP samples were screened by the Microtox® Assay and tested for mortality and DNA damage in fish embryos exposed using the comet assay.

Research Objectives and Approach

The primary research goal of this study was to investigate the environmental impacts of unbound reclaimed asphalt pavement (RAP) while it is freshly processed and after subjecting it to an accelerated weathering process. The secondary goal was to explore potential engineering. In addition, affordable treatment methods and remedies for unbound RAP applications where adverse environmental impacts have been identified will be explored.

Conclusions

Based on the tests conducted and the subsequent statistical analyses performed as part of this study, the following conclusions were drawn:

- Highly acidic (pH $\leq$ 4.0) leaching (e.g., in landfills where organic materials decompose creating an acidic environment) can lead to elution of lead (Pb) at a level higher than Maximum Contaminant Levels (MCLs). RAP batch extraction experiments demonstrated that levels of most metals in leachate are below EPA drinking water MCL. However, the same experiments showed that lead (Pb) in NORTHRAP and its weathered products exceeded or were close to the MCL of 15 ppb. This might be attributed to the historical usage of tetraethyl lead and white paint on the road (in northern NJ close to New York City). Levels of Fe and Mn are higher than secondary MCLs; possibly due to increased dissolution of minerals under acidic condition.

- Leaching of LMW PAHs from RAP under highly acidic conditions can be at a level of concern. Though the leaching processes mobilize on average less than 1 percent of these PAH compounds in the RAP materials investigated in this study, levels of certain compounds such in water leachate from batch experiments were higher than their EPA guidelines.
- NJ rainwater elutes negligible metals, indicating RAP can be used as unbound aggregates in surface, base, and subbase (except landfills). Column elution experiments showed that the concentrations for major or trace elements were below the US EPA's primary drinking water standards. These results are contradictory to those obtained from the batch experiments in the case of weathered and un-weathered NORTHRAP. This is most likely due to enhanced leaching provided by the acidic solution used in the batch extraction samples, as compared to the more neutral NJ's rainwater solution used in the column experiments.
- Microtox® screening analysis indicated that both weathered and un-weathered RAP samples were more toxic than the blank extraction material, although did not differentiate among them. However, these results must be viewed with some caution as the test appeared to be very sensitive to the acidic solution used in the RAP extractions even after readjustment of pH prior to testing. The column samples eluted with artificial rainwater were much less toxic, not even eliciting a measurable reduction in light from the bacteria in the Microtox® assay. Toxicity testing evaluating survival of Japanese Medaka fish embryos indicated that none of the batch samples were more toxic than the blank material used to extract them when mortality was compared. However, even the modified blank was toxic to the Medaka embryos as compared to embryo rearing medium (ERM). Analysis of weathered RAP samples indicated that some also induced toxicity in Medaka embryos. However, the most toxic treatment was the blank solution used to extract the weathered RAP.

Recommendations

The following are the recommendations from the study:

- RAP may be used as an unbound material in all environments except those which are highly acidic (pH ≤ 4.0) such as, but not limited to, mines with sulfur-containing minerals or landfills where other materials may decompose creating an acidic environment.
- Acceptable, beneficial, uses of unbound RAP materials may include, but are not limited to: using the unbound RAP as surface materials for parking lots, farm roads, or pathways; for quarry reclamation; as non-vegetative cover underneath guiderails; and mixed with other materials for subbase or base materials; in addition to the current uses in hot mix asphalt applications.
- Due to the inconsistent pollutant levels found among the three RAP stockpiles evaluated in this study, it is also recommended, as a precautionary measure, to determine the releasable levels of metals and PAHs for RAP stockpiles before using RAP in highly acidic environments; by extracting leachate samples using batch experiments and measuring pollutants (PAHs and metals) levels.
    - If the releasable levels of pollutants are below US EPA drinking water standards, unbound RAP can be used in all acidic environments.
    - If the releasable levels of metals and PAHs exceed US EPA drinking water standards, it is recommended to ensure that there is a soil layer between the RAP and the groundwater aquifer. It is important to note; however, that it was beyond the scope of this study to determine the type and thickness of the soil layer that is appropriate for the use of RAP.

For More Information Contact:

NJDOT Project Manager:	Mamun “Mac” Rashid
	609-530- 2897
	Mamun.Rashid@dot.nj.gov
Principal Investigator:	Yusuf Mehta, Ph.D., P.E.
	Rowan University
	856-256-5327
	mehta@rowan.edu

A final report is available online at: http://www.state.nj.us/transportation/refdata/research/.
If you would like a copy of the full report, send an e-mail to: Research.Bureau@dot.state.nj.us.

Environmental Impacts of Reclaimed Asphalt Pavement (RAP)

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