Tech Brief

Recycled Materials in Portland Cement Concrete

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BACKGROUND

Increasing waste volume, combined with and escalating costs for disposal, has resulted in a reassessment of public attitude regarding the way society handles its waste. This heightened awareness has given rise to a definite trend toward recycling and re-usage of a wide variety of solid waste materials. Reusing waste materials reduces disposal volumes and costs, conserves natural resources and may even generate revenue. Because highways require huge volumes of construction materials, and the availability of quality natural materials is diminishing, highway agencies have become frequent participants in efforts to recycle or reuse diverse waste materials.

HERE'S THE PROBLEM

New Jersey, one of the highly industrialized states in the nation, encountered severe waste management problems in the 1970s. Once the state disposal facilities reached their intended capacities, there became a need begin recycling of waste material as a remedy to the problem. However, even though recycling is in practice, there needs to be awareness of the various types of waste materials that can be used in highway construction. This can be promoted by publicizing their technical, economic and environmental impacts.

AND, HERE'S THE SOLUTION

NJDOT partnered with Rutgers University to conduct a series of experiments on the conventionally obtained by-products of the industry, as well as the recycled concrete itself. The effects on the structural behavior of Portland cement concrete will identify the recycled materials that can be successfully used in the production of Portland Cement Concrete.

BUT HOW CAN IT BE DONE?

To expand our knowledge, a literature survey on the waste materials and by-products will initiate the study. This will be followed by conducting laboratory tests for compressive and flexural strength on blends with various waste materials and percentages. Then we will perform an analysis of the results to determine their suitability in the mixes that can enhance the mix properties with no significant effect on the behavior of the PCC will follow.

THESE ARE OBJECTIVES…

- To investigate the suitability of using recycled glass, recycled concrete, and street sweepings with NJDOT class – A concrete mixtures.
- To study the mechanical properties and durability of such recycled mixes.
- To investigate the use of Granulated Blast Furnace Slag (GBFS) as a stand-alone additive, as well as in conjunction with other recycled materials, in order to examine the feasibility of its use with NJDOT concrete mixtures.

HERE IS WHAT WE DID…

The research work began with a literature survey on the use of Silica Fume, Blast Furnace Slag, Fly Ash, Recycled Concrete, Crushed Glass, Street Sweepings, Crumb Rubber, Plastics, Ceramic, and Sawdust as the additives in the production of PCC.

This was followed by conducting laboratory tests, such as compressive & flexure strength, permeability and accelerated mortar bar tests on these materials.

Next, an experimental program comprised of two distinct phases: (A) NJDOT class A mixtures; and (B) optimized mixtures; was conducted. This included development of four mixtures through usage of various recycled materials, which were later compared to a control mix containing ordinary constituents (e.g., cement, coarse and fine aggregates).

It should be noted that the materials used in the Phase -A that the compressive strength requirements were within the minimum range of specifications, but failed the durability tests.

What We Found…	**Our Recommendations…**
• Results from the study indicate that the recycled materials are not suitable for use with class-A concrete, unless the mixture is optimized with cementitious materials and other additives to remedy the durability problems.	• Street sweepings should not be used with any concrete mixture due to its variability. • Crushed glass and recycled can be used for concrete mixtures, but not Class A mixes. Crushed glass should not be used in structural concrete.

WHAT IS THE NEXT STEP?

As is evident from the experimental results, the materials tested in Phase –A would be reevaluated for their effects on the durability and strength of PCC; this would be done by manipulating some of the material properties through addition of other types of additives that could potentially enhance the mechanical properties of the final product. In addition, selected results from Phase –B, pertaining to CGC and RC concrete, that were reiterated, shall be reevaluated for completeness.

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A final report is available online at http://www.state.nj.us/transportation/research/research.html

If you would like a copy of the full report, please FAX the NJDOT, Bureau of Research, Technology Transfer Group at (609) 530-3722 or send an e-mail to Research.Bureau@dot.state.nj.us and ask for:

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