Performance Evaluation of Concrete Pavement Granular Subbase

tech transfer summary

Traditional use of virgin material in the subbase layer of pavements creates a high impact economically and environmentally.

Objectives

The main objectives of this study were to

- determine if RPCC pavement subbase is performing adequately by evaluating representative pavement sections with comparisons to virgin aggregate subbase sections;
- evaluate the spatial variation in subbase stiffness and permeability by performing multiple tests within a given test section using semi non-destructive methods;
- determine the gradation of the subbase materials;
- evaluate the pavement drainage system at each test section site by inspecting the subdrain outlets; and
- develop suggested material guidelines and specifications for construction of pavements using RPCC aggregate for subbase as needed.

Problem Statement

Newly-built and/or reconstructed pavements require significant quantities of aggregate material for the subbase layer. Traditional use of virgin material creates a high impact economically and environmentally. At the same time, it is very expensive to deposit waste concrete material from reconstructed pavement due to the transportation and environmental expenses. Using recycled Portland cement concrete (RPCC) aggregate for road construction is currently a widely used option for subbase layers. Re-used RPCC reduces the need for natural aggregates, preserves

Preparation for field tests

PGA
Partnership for Geotechnical Advancement

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RESEARCH PROJECT TITLE
Performance Evaluation of Concrete Pavement Granular Subbase—Pavement Surface Condition Evaluation

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The Partnership for Geotechnical Advancement (PGA) is part of the Center for Transportation Research and Education (CTRE) at Iowa State University. The mission of the PGA is to increase highway performance in a cost-effective manner by developing and implementing methods, materials, and technologies to solve highway construction problems in a continuing and sustainable manner.

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the environment, and does not occupy landfill space. However, RPCC aggregate can reportedly experience reduced permeability, clog drainage systems, and produce a leachate with high pH that can corrode metal drainage pipes and damage vegetation. These engineering properties could potentially result in reduced durability of pavement bases, affecting long-term performance of pavement.

The Iowa Department of Transportation (DOT) currently uses the same specifications for natural and recycled concrete aggregates, even though these aggregates have different physical, chemical, and mechanical properties. Based on these potential problems, this research was aimed at developing special guidelines and specifications for using RPCC in pavement subbase as needed based on the results of a comprehensive field test program.

Research Description

This research project included in-situ testing of full-scale test sections of subbase materials on constructed pavements. Dynamic cone penetration (DCP), Clegg impact hammer, and light weight deflectometer (LWD) tests were conducted on the subbase and/or subgrade surface to analyze stability. The results were used to develop comparisons and correlations. Permeability testing was conducted at each site using a permeameter developed for field applications by the Minnesota Department of Transportation (Mn/DOT).

Twenty-six test locations, including 21 sites with RPCC subbase materials and six test sites with virgin subbase materials were investigated (Table 1). A testing plan with the described testing methods was implemented at each site. Subbase aggregate samples were collected and tested in the laboratory for gradation, abrasion and other index properties.

Dynamic cone pentrometer (DCP) test

The results were analyzed to evaluate the relationship of stability and permeability among the virgin and RPCC subbases.

Key Findings

Laboratory and Field Investigation Findings

- Specific gravities of RPCC are significantly lower than those of crushed limestone.
- RPCC aggregate material vary from either poorly- or well-graded sand to gravel.
- Micro-Deval abrasion losses of virgin aggregate materials were within the maximum Micro-Deval abrasion loss of 30% recommended by ASTM D6028-06.
- Micro-Deval abrasion loss of RPCC aggregate materials was normally higher than the maximum Micro-Deval abrasion loss of 30% suggested by the ASTM D 6928-06.
- Modulus of elasticity of RPCC subbase materials is high and variable from one project to another.
- CIV obtained from many Clegg hammer tests are high.
- The CBR value obtained from a DCP test was lower than CBR converted from CIV.
- RPCC subbase layers normally have low permeability.

Distress Survey Findings

- The current pavement surface condition of RPCC subbase sections is comparable to that of virgin aggregate subbase sections in terms of the Pavement Condition Index (PCI) and the International Roughness Index (IRI).
- Based on the evaluation of representative RPCC subbase pavement sections with comparisons to virgin aggregate subbase sections, it can be concluded that the RPCC pavement subbase is performing adequately.
- The pavement surface condition history of RPCC subbase sections is not much different from that of virgin aggregate subbase sections.
- Few longitudinal and transverse cracks were observed on all test sections evaluated in this study. The featured distresses on RPCC are the lane-to-shoulder separation and lane-to-shoulder drop off, which are consistent with the findings reported by previous researchers.
- No correlation was observed between the pavement surface condition indices and the RPCC subbase thickness.