USE OF RECYCLED CONCRETE MADE WITH FLORIDA LIMESTONE AGGREGATE FOR A BASE COURSE IN FLEXIBLE PAVEMENT

PROBLEM STATEMENT

The lack of landfill sites for waste disposal and the potential exhaustion of natural resources have led government and industry to consider the use of recycled wastes from old concrete structures as a new source of construction materials. In order to successfully use the recycled materials in pavement construction, it is necessary to develop a set of Florida Department of Transportation (FDOT) guidelines and specifications.

OBJECTIVES

The objectives of this research study are (1) to investigate the feasibility of using recycled concrete aggregates (RCA) as a base course material in asphalt pavement, (2) to evaluate the physical properties of RCA, and (3) to develop practical and reliable guidelines and specifications for the use of RCA.

FINDINGS AND CONCLUSIONS

Researchers conducted a series of laboratory tests on RCA samples to determine their physical and engineering properties. The results of the laboratory tests are summarized in the table below.

Type of Test	Average Test Results
Gradation Test	**Average Gradation**
Sieve No.	
50 mm	100.0
37.5 mm	99.5
19 mm	83.2
9.5 mm	61.2
# 4	44.8
# 10	34.4
# 50	15.7
# 200	3.8
LBR Test	181.71
LA Abrasion Loss	44.02%
Sodium Sulfate test	52%
Sand Equivalent	70.5%
Heavy Metals	0 - 12 ppm
Asbestos	Free of Asbestos
Optimum Moisture Content	11.2% - 12.1%
Maximum Dry Unit Weight	113.8 lb/ft^3 – 114.8 lb/ft^3
Permeability	0.72 (ft/day)
Impurities	1.99% by weight
Structural Layer Coefficient (based on LBR value)	0.16

The findings of this project support the hypothesis that RCA can effectively be used as a base course when quality control techniques are utilized. Consequently, the researchers recommend the following tests, guidelines, and specifications.

RCA producers should provide some or all of the data suggested by the following tests: gradation, LBR, LA Abrasion Loss, sodium sulfate, sand equivalent, heavy metals, optimum moisture content and maximum dry unit weight, permeability, impurities, asbestos, and material characterization (resilient modulus). Further, the following guidelines should be considered during selection and processing of RCA:

1. Before processing, the contractor must carefully select the demolished building or other structure and plan to have a separate storage area for the rubble.

2. Reinforcing steel must be removed by using an overhead magnetic separator. Then, impact mills can be used to crush the rubble into various sizes. Finally, air classifiers should be used to remove lightweight debris such as wood and plastic.

3. The RCA should be washed before using. Washing is also required to remove the dust as a measure of reducing potential tufa (porous limestone formed from calcium carbonate) formation. Additional quality control testing may be necessary to estimate the tufa precipitate (leachate) potential of RCA aggregates for embankment applications.

4. The material must possess comparable compressive and shear strengths of natural aggregate, meet gradation of particle size distribution, and provide proper workability.

5. RCA must not contain harmful impurities such as lead and asbestos, and it must not react with either cement or reinforcement when it is used for concrete add mixtures.

6. The output quality must be guaranteed by systematic and rigorous monitoring, as well as intensive sampling and testing of the material characteristics (including environmental properties).

Based on the results of this study, the researchers recommend the specifications summarized in the table (page 3) for the use of RCA as a base material in flexible pavements.

Type of Test	Proposed Specifications	FDOT Specifications
Gradation Test	**Gradation Limits (90% Confidence Interval)**	**Section 204**
Sieve No.	---	---
50 mm	Min. 100 - Max. 100	Min. 100 – Max. 100
37.5 mm	Min. 98 - Max. 100	Min. 95 – Max. 100
19 mm	Min. 65 – Max. 100	Min. 65 – Max. 90
9.5 mm	Min. 40 – Max. 83	Min. 45 – Max. 75
# 4	Min. 27 – Max. 63	Min. 35 – Max. 65
# 10	Min. 20 – Max. 49	Min. 25 – Max. 45
# 50	Min. 8 – Max. 24	Min. 5 – Max. 25
# 200	Min. 2 – Max. 6	Min. 0 – Max. 10
LBR Test	Min. 120	100
LA Abrasion Loss	**90% confidence Interval**	**Section 204**
	< 48%	< 45%
Sodium Sulfate test	N/A	15%
Sand Equivalent	N/A	≥ 28%
Heavy Metals	5 ppm	5 ppm
Asbestos	Free of Asbestos	Section 112 EPA
Optimum Moisture Content	**90% confidence Interval**	**See Section 200-6.4**
	10% - 12%	No Proper Values
Maximum Dry Unit Weight	**90% confidence Interval**	**Limerock**
	108 lb/ft^3 – 120 lb/ft^3	98% of Max. Dry Density
Permeability	0.10 to 1.40 (ft/day)	No Proper Values
Impurities	< 2.0% by weight	Substantially free of Impurities
Structural Layer Coefficient	0.16	0.15 (Standard Index 514)
Thickness Requirement	Min. 8.0 in. (20.3 cm)	10.5 in. (26.7 cm) Proposed for Limerock

The results of this research study provide agencies such as the FDOT with information necessary for making decisions regarding the development and/or improvement of standard specifications for the broader use of RCA in roadway pavements.

This research project was conducted by Shiou-San Kuo, Ph.D., P.E., at the University of Central Florida. For more information, contact Abdenour Nazef, P.E., at (352) 337-3265, abdenour.nazef@dot.state.fl.us .