MACTEC

engineering and constructing a better tomorrow

December 4, 2009

Kyle LaClair, P.E.
Dewberry
4180 Innslake Drive
Glen Allen, Virginia 23060-3344

Tel: 804-290-7957
E-Mail: klaclair@Dewberry.com

Subject: **Report of Subgrade Stabilization**
Richmond Airport Connector Road Project
Henrico County, Virginia
Dewberry Project No. 50017892
MACTEC Project No. 3602-08-1453.20

Dear Mr. LaClair:

MACTEC Engineering and Consulting, Inc. (MACTEC) is pleased to provide this report of the pavement subgrade stabilization study for the proposed Richmond Airport Connector project located in Henrico County, Virginia. Our services were provided in general accordance with our Proposal for Supplemental Geotechnical Engineering Services – REV. 1 (MACTEC Proposal No. PROP09RICH.050) dated September 8, 2009 and following authorization by you via E-mail communication.

Background Information

The proposed 1.6 mile long Richmond Airport Connector Road is located south of the existing Richmond International Airport (RIC) and north of the existing Route 895 in eastern Henrico County, Virginia. The intent of the proposed construction is to provide a 4-lane toll roadway that will provide a direct limited access highway link between Rte-895 and RIC. We understand that the construction Contractor, American Infrastructure, plans to use existing stockpile material adjacent to the project site for the proposed roadway embankment fill.

During project planning stages, several classification tests have been conducted on the soils collected from the stockpiles. The test results showed that the soils have relatively high plasticity. Based on the results of the initial classification tests, two batches of four samples labeled as RAMP-A and ACR-A were collected for further study.

The purpose of this study is to provide engineering analysis and recommendations for the stabilization of the pavement subgrade soils from the stock piles. The scope of this task includes a series of laboratory tests to determine the potential additives and content, compaction requirement, and construction related quality control.

The potential additives for the stabilization were provided by Slurry Pavers, Inc. who was identified by American Infrastructure as the subcontractor for the subgrade stabilization.

Laboratory Testing

The following tests were performed by MACTEC laboratory in Ashburn, Virginia, which is a R18 accredited laboratory by AASHTO:

- Soil Classification (ASTM 1487)
- Eades – Girm Test (ASTM D 6276)
- Modified Proctor (ASTM D1557)
- Unconfined Compressive Strength (ASTM D5102)

Table 1 provides the classification test results for four soil samples collected from the stockpiles.

Table 1. Soil Classification Test Results for the Stockpile Soils

Sample Identification	Passing No.4 Sieve (%)	Passing No.200 Sieve (%)	Liquid Limit (%)	Plastic Limit (%)	Plasticity Index (%)
RAMP-A	100	74	49	31	18
RAMP –A-a	100	76	50	32	18
ARC	100	79	52	31	21
ARC-a	100	75	50	31	19

As indicated in Table 1, soils collected from different stockpiles appear to have similar engineering properties in terms of classification and for the purpose of stabilization. After discussion with American Infrastructure, MACTEC recommended to mix all the soil samples listed in Table 1 for the subsequent laboratory tests.

Table 2 lists the classification test results after all the samples were mixed.

Table 2. Soil Classification Test Results for Mixed Stockpile Samples

Sample Identification	Passing No.4 Sieve (%)	Passing #200 Sieve (%)	Liquid Limit (%)	Plastic Limit (%)	Plasticity Index (%)
RAMP-A + ARC	100	80	50	32	18

Based on the soil classification test results and experiences provided by the soil stabilization industry, lime and Calcement were selected as potential additives for the stabilization.

To determine the lime content, an Eades – Girm Test (pH test) was performed in accordance with ASTM D 6276. Table 3 provides the results of this testing.

Table 3. Lime Content Test Results

Lime Percentage	2%	3%	4%	5%	6%
pH value	12.30	12.31	12.33	12.34	12.36

Based on the pH test results, three lime contents of 5%, 7%, and 9% were selected for the subsequent tests. Additional Calcement contents of 6% and 8% were selected to be performed separately. Table 4 and Table 5 provide the test results with respect to the compaction and strength.

Table 4. Proctor Test Results

Stabilizer	Content	Maximum Dry Density (pcf)	Optimum Moisture Content (%)
Lime	5%	108.6	19.3
	7%	108.0	19.0
	9%	107.6	19.4
Calcement	6%	111.0	18.0
	8%	110.4	17.9

Table 5. Unconfined Compressive Strength Tests Results

Stabilizer	Content	Actual Compaction Effort	48 Hour Strength (psi)*	28 Day Strength (psi)*
Lime	5%	95%	212	114
	7%	95%	215	185
	9%	92%	218	62
Calcement	6%	94%	207	154
	8%	92%	216	164

*Forty-eight hour strength samples were tested using accelerated curing at 120 degrees Fahrenheit. Twenty-eight day strength samples were tested using regular curing process.

Engineering Recommendations

Stabilized soils can typically achieve unconfined compressive strengths ranging from 100 psi to 1000 psi. The test results for the soil samples indicate the unconfined compressive strengths ranging from 62 psi to 218 psi, depending on the percentage of the additives and the method for sample curing.

Since Calcement has an apparent economic advantage over lime, it is our opinion that Calcement should be considered as the preferred additive for the pavement subgrade stabilization.

Based on the laboratory test results, we recommend that an application rate of 6% of Calcement by weight be added to the pavement subgrade area for the stabilization. Once the Calcement is well mixed into the subgrade soils, the mixture should be compacted to a minimum of 94% of the maximum dry density using Modified Proctor in accordance with ASTM D 1557. The moisture of the soil-Calcement mixture should be maintained at ±2% of the optimum moisture content estabilished by the Modified Proctor testing. Results of MACTEC laboratory testing indicate a maximum dry density of 111 pcf and an optimum moisture content of 18% based on the Modified Proctor testing.

Provided that the soils are suitably stabilized using the recommended stabilizer and adoption of an adequate construction quality control program outlined in the following section, we recommend that a structural layer coefficient of 0.12 to be considered for the AASHTO pavement design.

Construction Quality Control

Quality control is essential to ensure that the final product will be adequate for its intended use. It must also ensure that the subcontractor has performed the work in accordance with the plans and specifications.

The most important factors to control during soil-Calcement construction are pulverization and scarification, Calcement content, uniformity of mixing, time sequence of operations, compaction and curing.

Before application of Calcement, the soil should be scarified and pulverized. To assure the adequacy of this phase of construction, a sieve analysis is typically performed. Most specifications are based upon a designated amount of material passing the 1 inch and No. 4 sieves. The depth of scarification or pulverization is also of importance as it relates to the specified depth of Calcement treatment. For the project site soils, special attention should be paid to the agglomerated soil-Calcement fractions. These fractions can be easily broken down with a simple kneading action and are not necessarily indicative of improper pulverization.

When Calcement is applied to the pulverized soil, the rate at which it is being spread can be determined by placing a canvas of known area on the ground and, after the Calcement has been spread, weighing the Calcement on the canvas. Charts can be made available to field personnel to determine if this rate of application is satisfactory for the Calcement content specified.

Primarily important is the proper control of moisture-density. Conventional procedures such as sand cone, rubber balloon, and nuclear methods have been used for determining the density of compacted soil Calcement mixtures. Moisture content can be determined by either oven-dry methods or nuclear methods. The influence of time between mixing and compacting has been demonstrated to have a pronounced effect on the properties of treated soil. Compaction should begin as soon as possible after final mixing has been completed. The delay of the compaction should be less than 48 hours after the application of the Calcement.

Curing is essential to assure that the soil Calcement mixture will achieve the final properties desired. Curing is accomplished by one of two methods: moist curing, involving a light sprinkling of water and rolling; or membrane curing, which involves sealing the compacted layer with a bituminous seal coat. Regardless of the method used, the entire compacted layer must be properly protected to assure that the Calcement will not become nonreactive through carbonation. Inadequate sprinkling which allows the stabilized soil surface to dry will promote carbonation.

We appreciate the opportunity of serving as your consultant on this project and look forward to our continued association. Please contact us if any questions arise or if we may be of further service.

Sincerely,
MACTEC ENGINEERING AND CONSULTING, INC.

Robert H. Vester, P.E.
Project Engineer

Anna Kotas
Senior Engineer

John Z. Ding, P.E.
Senior Principal Engineer

Appendix:

Lab Test Results