AN EVALUATION OF STRENGTH GAIN IN SOIL~SEMENT AMENDED UNPAVED ROADS, SCOTTSDALE, AZ

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Abstract

Vinyl polymer stabilization agents, such as Midwest Industrial Supply's Soil~Sement, seem to greatly influence if not dominate the structural performance of sandy materials. So much so that the performance of Soil~Sement stabilized materials may be anticipated if not predicted.

Testing in Scottsdale, AZ during May, 2007 identified significant structural improvement provided by the Soil~Sement stabilization of a sandy unpaved, low volume roads. The stabilization provided for a significant increase in the road's resistance to deformation (stiffness). Historically, the stiffer and uniformly stiff a roadway is, the longer period of time between repairs. Within days of stabilization, stiffness had uniformly increased ~ 18% relative to what it was one day after agent installation. Generally, the stiffness exhibited was equivalent to a quality low traffic volume road paved with several inches of HMA (~ 20 MN/m). Two to three years after stabilization, stiffness uniformly increased ~ 50% to 65% relative to what it was one day after agent installation. Years into their life cycle, the Soil~Sement stabilized roads demonstrated a stiffness expected of a moderate volume paved road (~ 30 MN/m).

The stiffness gained with Soil~Sement stabilization was found to be well behaved as a function of time to a high degree of correlation. The predictability of the stiffness or strength gain appeared sufficient that it may be used as the basis of a performance specification.

Introduction

Two days of testing were conducted during 9 and 10 May, 2007 with the Midwest Samitron on five sections of Soil~Sement amended unpaved, low volume road in Scottsdale, AZ. Dennis Casamatta and Melvin Main of Midwest Industrial Supply, Inc. and Marty Koether of EarthCare Consultants performed the testing.

Objective

The objective of the testing was to determine if the performance of a Soil~Sement amended unpaved road was sufficiently well behaved to be predictable. This testing was intended as a precursor to the development of performance specifications and QC methods to control the installation of Midwest products using in-place stiffness.

Test Sites

Five sites were tested. These sites were:

- Site 1: Davis Rd., ~ 200' west of intersection Scottsdale Rd., ~ 1 day & 2 days old (days after Soil~Sement installation)
- Site 2: 71st St., ~ 200' north of intersection with Windstone, ~ 2 days old
- Site 3: Via Donna Rd., ~ 500' east of intersection with Scottsdale Rd., ~ 2 months old
- Site 4: 76 th St., ~ 200' south of intersection with Via Donna, ~ 2 yr. old
- Site 5: Via Donna Rd., ~ 50' east of Hayden, ~ 3 yr. old

The soil at each site was silty sand, AASHTO A-2-4. The soil at each site was amended with Soil~Sement to a depth of ~ 4 in. Water dilution rates varied with ambient temperatures and soil moisture at the time of application. The rate was usually 1:8 (1 part Soil~Sement to 8 parts water) however after rains it was 1:4 to account for wetter soil. The amount of undiluted product that was applied per unit area was the same regardless of dilution rate. The application rate for that depth was .36 gallons of Soil~Sement per square yard of treated soil. Of that, a total amount of 25% to 30% was used for a topical sealing of the amended road after compaction. This occurred in two or three topical coatings.

Tests Performed

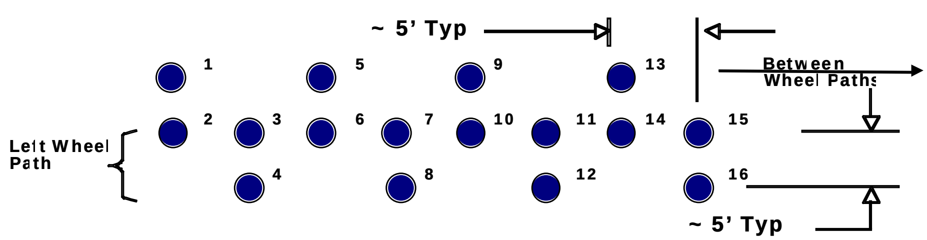
Sixteen Samitron measurements per ASTM D-6758 were made at each site (Figure 1). Measurements on all sites required the use of moist mortar sand to seat the Samitron, as the surface was often hard and dry. The measurement data is presented in Table 1.

Table 1: Measurement Data

Test Location	Stiffness MN/m						
	Test Site 1 (~ 24 hr.)	Test Site 2 (~ 48 hr.)	Test Site 3 (~ 2 months)	Test Site 4 (~ 2 yr.)	Test Site 5 (~ 3 yr.)	Test Site 1 (~ 48 hr.)	All 48 hr. Data
1	17.21	17.53	19.56	26.85	25.39	27.42	
2	19.95	15.12	15.49	28.67	38.30	22.43	
3	18.04	15.96	24.44	24.80	30.23	15.74	
4	14.72	16.30	25.97	28.17	37.89	18.21	
5	13.98	19.94	28.87	26.50	28.65	24.63	
6	17.42	14.43	19.46	27.12	27.74	25.14	
7	16.34	24.45	25.87	21.74	20.47	21.62	
8	14.90	18.68	24.30	24.51	24.27	19.14	
9	16.89	21.62	26.96	31.51	33.29	18.69	
10	15.82	13.26	20.97	31.71	29.26	22.37	
11	18.00	22.33	22.69	25.34	23.32	23.61	
12	17.25	24.37	26.96	23.14	29.19	20.32	
13	17.36	23.12	26.09	31.71	34.61	23.51	
14	16.54	14.80	19.84	28.13	32.54	27.38	
15	19.40	20.98	20.91	27.68	27.68	27.22	
16	27.27	18.53	22.94	26.41	23.84	23.57	
Average	17.57	18.84	23.21	27.12	29.17	22.56	20.70
Standard Deviation	3.03	3.68	3.60	2.91	5.16	3.47	4.00
COV (%)	17.27	19.55	15.53	10.74	17.70	15.38	19.30
Ž re Site 1 Average, %		7.23	32.10	54.40	66.02	28.43	17.83

Figure 1

Sampling Pattern for All Sites



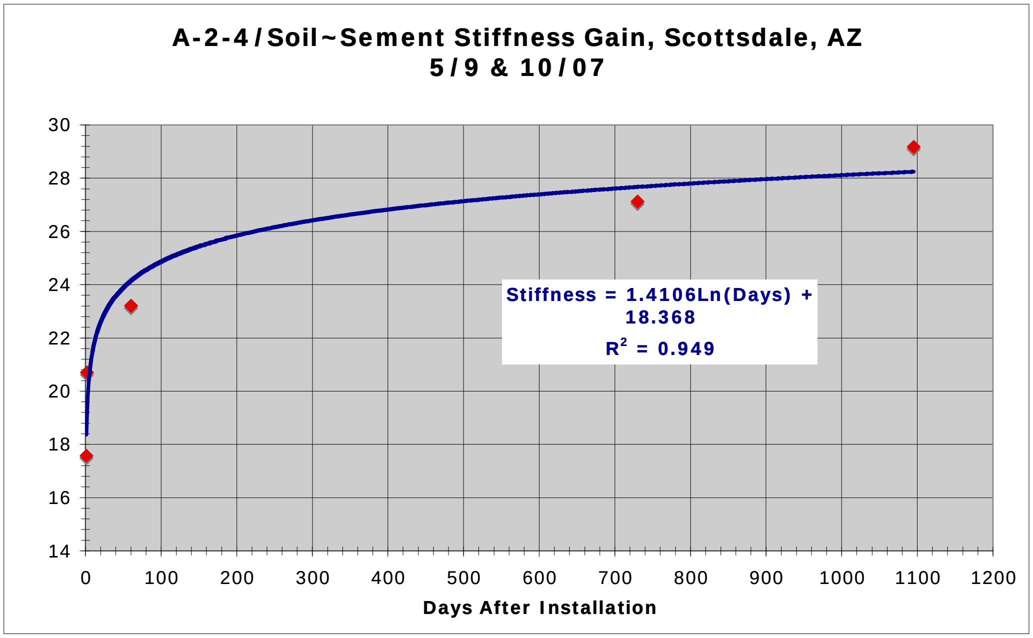
Results & Analysis

When the test results for the Soil~Sement amended silty sand are graphically represented, the mean stiffness for all five sites, representing 3 years of aging, lie on the same logarithmic curve with a high degree of correlation (Figure 2). Since the cure rate of most materials is logarithmic, this data strongly suggests that the rate of stiffness or strength gain is very consistent between the sites. It also suggests that the performance of the Soil~Sement amended road is predictable. The stiffness uniformity of is higher than most roads Midwest has evaluated. A uniformity represented by a coefficient of variation of ~ 13% for in-place stiffness is considered ideal by the FHWA. The largest coefficient for the Soil~Sement amended silty sand is 19.6%.

Site Conditions

The weather on May 9 and 10 was sunny and dry, temperature in the 80s and winds below 5 mph. During both days, low traffic volume was experienced (< 10 vehicles per hour).

Figure 1



Samitron Bias & Precision

Samitron operation was verified on its inertial isolated mass before each day of testing. A coefficient of variation (COV) of less than 1% about the expected value of stiffness was measured on the mass for 3 Samitron measurements. Samitron measurements were repeated at Site 1 to evaluate measurement precision. At this site, the COV for 3 measurements was 3.3%.

Conclusions and Recommendations

Samitron measurements are readily able to quantify the rate of strength (stiffness) gain for the Soil~Sement amended silty sand. Judging from the consistency and uniformity of the Samitron measurements, there is apparently good control of native material, stabilization (amendment with Soil~Sement) and compaction. Samitron measurements indicate that the rate of strength gain is predictable.

It is therefore possible to quantify from empirical Samitron data the needed roadway strength or stiffness. Using the Samitron, a prepared unpaved road can be evaluated as to whether it needs stabilization or not. If it does, then Samitron measurements can quantify the amount of stabilization (stiffening) achieved.

CBR measurements of stabilization on molded laboratory samples could be used to customize mixes for a variety of materials and related to expected in-place stiffness.[1] Using the Samitron on the same laboratory samples, cures rates (rate of strength gain) can also be defined. These laboratory measurements can be used to define the short-term strength gain of in-place stabilized materials and predict when the material can be released to loading and what its ultimate strength will be.

Following is a recommendation of how the in-place performance in terms of stiffness should be defined and evaluated for a Soil~Sement amended AASHTO A-2 soil. It is based on the testing in Scottsdale, AZ. It is assumed that the performance of the Scottsdale roads is satisfactory and typical. It is also preliminary until additional tests, like those done in Scottsdale, can be done on the same soil class on jobs elsewhere in the United States.

In-Place Stiffness Requirements & QC Measurements

At two different times early in the life of the installation separated by a minimum of 1 day (e.g., 1 and 3 days), stiffness measurements will be made on the roadway per ASTM D 6758. These measurements should be made every 500 ft. at random locations. The installation will be judged acceptable if the average of all measurements

Figure 3
Acceptable Stiffness Limits
Soil~Sement Amended ASSHTO A-2 Silty Sand

[1] Assessment Of In-Situ Test Technology For Construction Control Of Base Courses And Embankments, 2004, Murad Y. Abu-Farsakh, Ph.D., P.E., Khalid Alshibli, Ph.D., P.E, Munir Nazzal, and Ekrem Seyman, Louisiana Transportation Research Center, Baton Rouge, LA 70808, FHWA/LA.04/385

and all individual measurements are within the limits defined in Figure 3. The limits in this figure are valid for the same mix and construction methods as those used on the Scottsdale, AZ roads, from which the data in the figure came.