OFFICE OF MATERIALS MANAGEMENT
CHEMICAL SECTION

Recycled Portland Cement & Concrete /Soil Mixtures

And

pH

February 2002

TEST METHOD FOR DETERMINING WHETHER RPCC IS STABILIZED

Goal

This test method is developed to evaluate the change in pH and/or the ability to stabilize RPCC by the addition of soil to recycled portland cement concrete (RPCC) by percent by weight. The results would be to establish what percent, if any, of soil mixed with RPCC will eliminate Tufa or eliminate high ph and runoff damage to roadway drainage systems.

Procedure:

Initial tests

1. Produce six (6) RPCC samples where the largest size passes a 1" sieve, the sample is well graded, and the sample size is about 10 lbs.

2. Screen a sufficient quantity of soil through a No.8 sieve. Store the soil in a closed container to maintain uniform moisture if not mixing the soil with the RPCC within 2 hours.

3. Prepare seven samples for the test. Five samples (5) RPCC/soil samples so that the soil percent, by weight, meets the table below. One (1) RPCC sample with no soil added and one (1) soil sample of 10 pounds with no RPCC.

Percent of soil to be added to 10 lb. RPCC sample, by weight of soil	Weight of soil to be added to 10 lb. RPCC	Total weight of RPCC- soil mixture, lbs.
0	0 lb	10
9.1	10 lb. x 0.1 = 1 lb	11
16.6	10 lb. x 0.2 = 2 lb.	12
23.1	10 lb. x 0.3 = 3 lb.	13
28.6	10 lb. x 0.4 = 4 lb.	14
33.3	10 lb. x 0.5 = 5lb.	15
100	n/a	10

4. Select a container size that will hold the sample approximately 1/3rd full..
Estimated size would be - (15 lb/90) = .16673 cubic foot (28.317 L) = 4.7/.67 = 7L/3.875 = 2 gal bucket.

Use the same size container for the RPCC sample with no soil and the soil sample with no RPCC.

1. Two methods for testing for pH:

A. Add volume of distilled water and mix until water absorbs and is free standing at the same level as the soil aggregate mix. Place lid tightly and shake on paint mixer for 5 minutes every hour.

(1) Transfer some slurry into a container for each sample and test for pH and record the results. Also record an visual, color or smell change.

(2) Wait 4 hours and repeat (a) for each sample and test for ph and record the results. Also record an visual, color or smell change.

i. Let sit for 48 hours and repeat (a 1) and (a 2) and record all results. Also record an visual, color or smell change.

ii. Let sit for 5 days and repeat (a 1) and (a 2) and record all results. Also record an visual, color or smell change.

B. Follow procedure (a) for adding and mixing distilled water until the volume of water is at the same level as the samples.

(1) Do not agitate the solution but allow to sit for 24 hours. Pull off moisture sample and test ph for all samples. Record all results including visual, color or smell change.

(2) Continue to allow samples to stand and test at 48 hours 120 hours, 7 days, 14 days and 21 days. Record all results including visual, color or smell change.

2. Evaluate the need to continue to test based on the changes in pH If the ph appears to flatline versus time stop the test. Look at soil/RPCC sample values versus the soil and the RPCC values.

pH TESTING OF RPCC/ SOIL MIXTURES

Weight of rpcc = 10 Lbs

Method A

Data

RPCC/Soil mixtures	Initial pH	4 hours	48 hours	120 hours
0% soil 10-0 mixture	10.19	10.31	10.57	10.69
9.1% soil 10-1 mixture	9.78	9.87	10.44	10.65
16.6% soil 10- 2 mixture	9.56	9.68	10.12	9.98
23.1% soil 10-3 mixture	9.51	9.56	9.80	9.78
28.6% soil 10-4 mixture	9.43	9.58	9.90	9.57
33.3% soil 10-5 mixture	9.34	9.53	9.91	10.18
100% soil 0-10 mixture	9.42	9.54	9.93	10.01

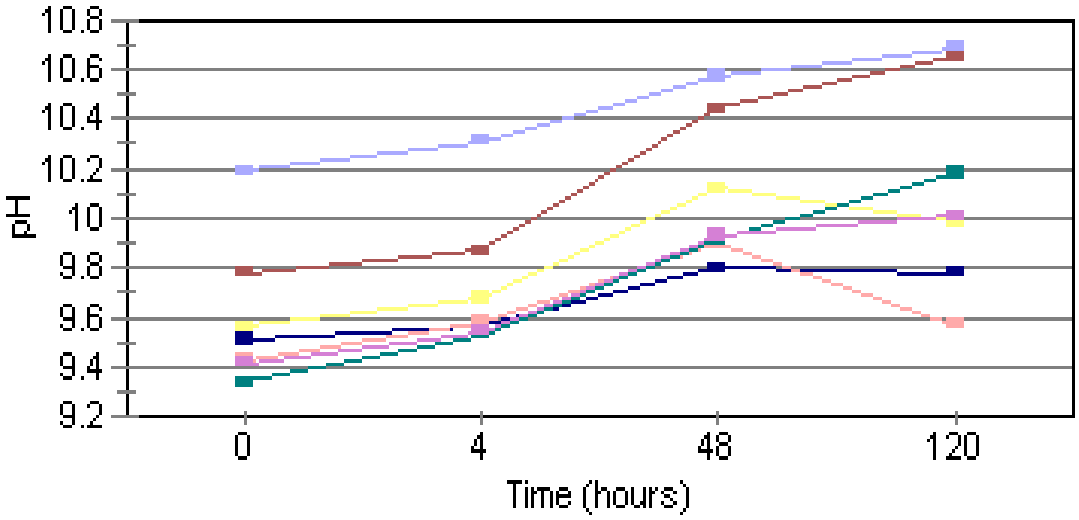
No changes in visual, color, or smell, throughout test.

Graph Color chart

pH vs. Time		pH vs. % Soil	
blue	100% rpcc	navy blue	120 hours
red	9.1% soil	yellow	48 hours
yellow	16.6% soil	red	4 hours
navy blue	23.1% soil	blue	0 hours
pink	28.6% soil		
green	33.3% soil		
purple	100% soil		

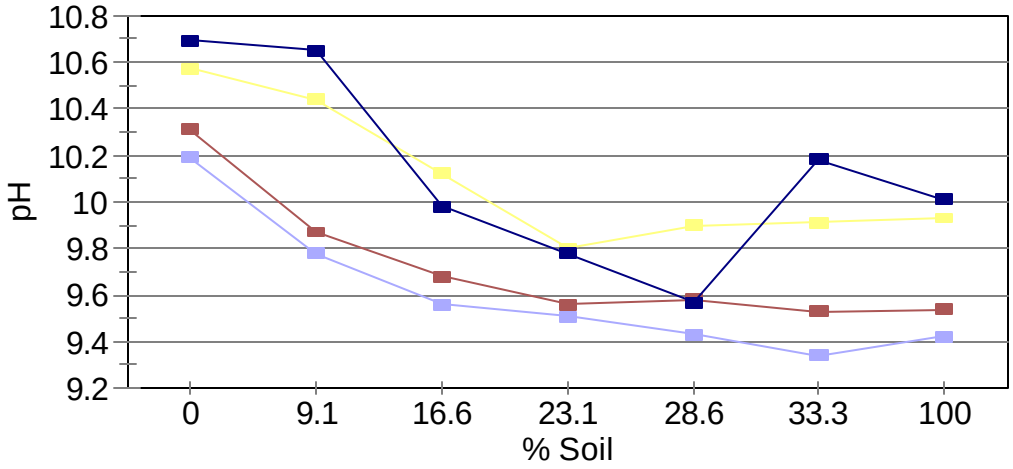
pH of RPCC/Soil Mixtures

Changes of pH Over Time



pH of RPCC/Soil Mixtures

Decrease of pH w/increasing % Soil



Conclusion

Trends

The data shows a general trend of slightly decreasing ph with the increase of the amount of soil in the mixture. The initial pH of the soil was 9.42. The initial pH of the recycled Portland cement concrete was 10.19. The difference in the two pH values is 0.77 units. The overall change in pH cannot be great when the difference between the components of the mixtures is so small. Thus, as far as eliminating the high pH of Tufa, the initial pH of the soil needs to be lower. There is also a trend showing increasing pH over time. This second trend can be explained, even for the soil, by the release of bases through the dissolution of the samples with water. (A Textbook of Chemical Analysis, Chemical Publishing Co., Inc. By: P.R. Hesse, Pg. 465)

The data shows that the best results in lowering pH values, or rather in keeping the increase in the pH values at a minimum, to be the 40% mixture. The smallest difference between the initial pH of pure soil and a mixture was with the 40% sample. The 40% RPCC/soil mixture also shows the least increase in pH from the initial pH to the final pH reading.

% Soil	Initial pH - Final pH	100% Soil initial pH - Initial pH of mixtures
0% Soil	-0.5	-.077
10% Soil	-0.87	-0.36
20% Soil	-0.42	-.040
30% Soil	-0.27	-0.09
40% Soil	-0.14	-0.01
50% Soil	-0.75	-0.08
100% Soil	-0.59	0

In considering a soil to mix with RPCC to eliminate the high pH associated with Tufa, it is necessary to start with soil that has a pH much lower than that of the recycled concrete. Urban soils are usually higher in pH because of the cement used in the construction of roads, sidewalks, etc. Top soil, rich in organic matter, tends to be acidic with a pH lower than 7.
(http://www.extension.umn.ed/distribution/horticulture/components/1731-03.html)

Recycled Portland Cement & Concrete/Soil Mixtures

Part 2

July 2002

Introduction

In this part of the experiment soil of lower pH relative to the soil used in the first part of the experiment will be used to attempt to lower the pH of recycled Portland cement.

The Department of Natural Resources provided information concerning soil pH of various regions of Ohio. It was determined that soil of low pH was to be found in the northeastern and southeastern parts of the state. Districts 4 and 10 were able to send 25 lb. surface to 6 inch soil samples.

The samples from both districts will be tested and the soil with the lowest pH values will be used for the second phase of the experiment.

Procedure for selection of soil

Fill a 100ml beaker with enough soil sample to reach the 50ml mark. Add tap water until the top of the sample is barely covered. Stir to reach a smooth consistency. Take the pH of sample and record. Repeat for all samples.

Soil sample pH values

Location of soil sample	pH (n=4)	Color
District 4 Ashtabula County	**4.75**	Light yellowish brown
District 4 Trumbull County	**5.75**	Light sandy brown
District 10 (Nob I 77)	**7.97**	Dark Brown

The soil from District 4, Ashtabula County, will be used for the experiment since it had the lowest average pH value.

The soil will be run through a number 8 sieve. The recycled concrete will be run through a 1 inch sieve.

PH TESTING OF RPCC/ SOIL MIXTURES

The procedure for taking the pH of the samples will be as in the first part of the experiment.

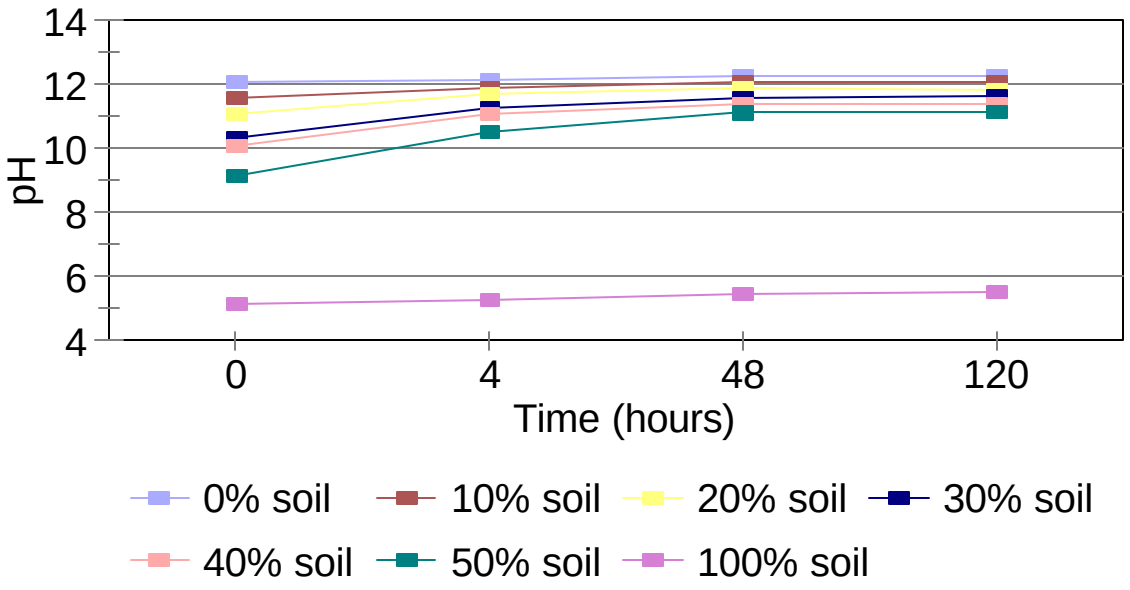
Total weight of samples = 10 Lbs

Method A

RPCC/Soil (lbs.)	Initial pH	4 Hours	48 Hours	120 hours	264 hours	432 hours
0% Soil	12.09	12.15	12.29	12.28	12.27	12.26
10 % Soil	11.60	11.91	12.09	12.08	12.06	12.08
20% Soil	11.11	11.69	11.87	11.83	11.82	11.80
30% Soil	10.36	11.27	11.61	11.63	11.60	11.65
40% Soil	10.08	11.10	11.38	11.38	11.43	11.39
50% Soil	9.16	10.54	11.13	11.18	10.94	11.14
100% Soil	5.12	5.27	5.47	5.53	5.80	6.20

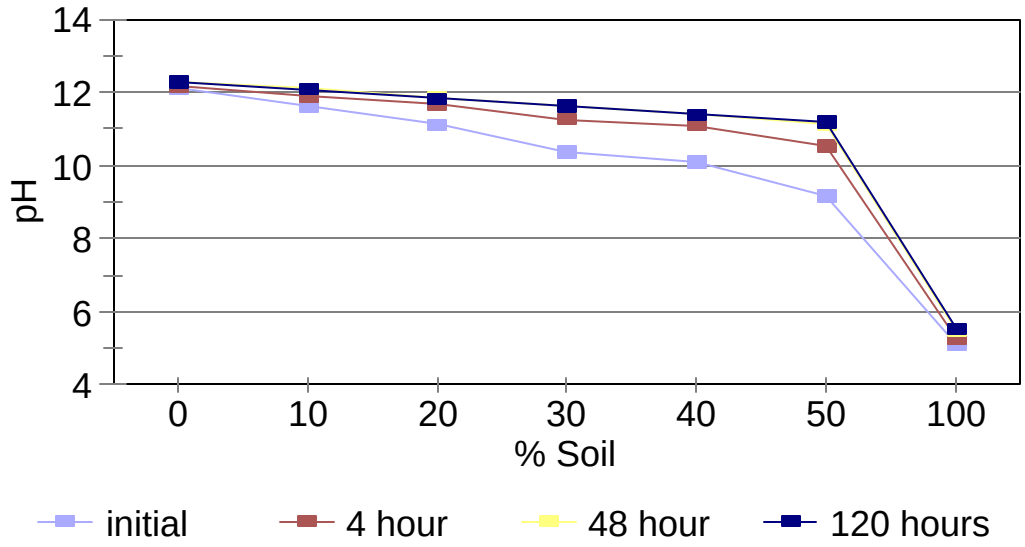
pH of RPCC/Soil Mixtures (Part I

Changes of pH Over Time



pH of RPCC/soil Mixtures (Part II)

Decrease of pH w/increasing % Soil

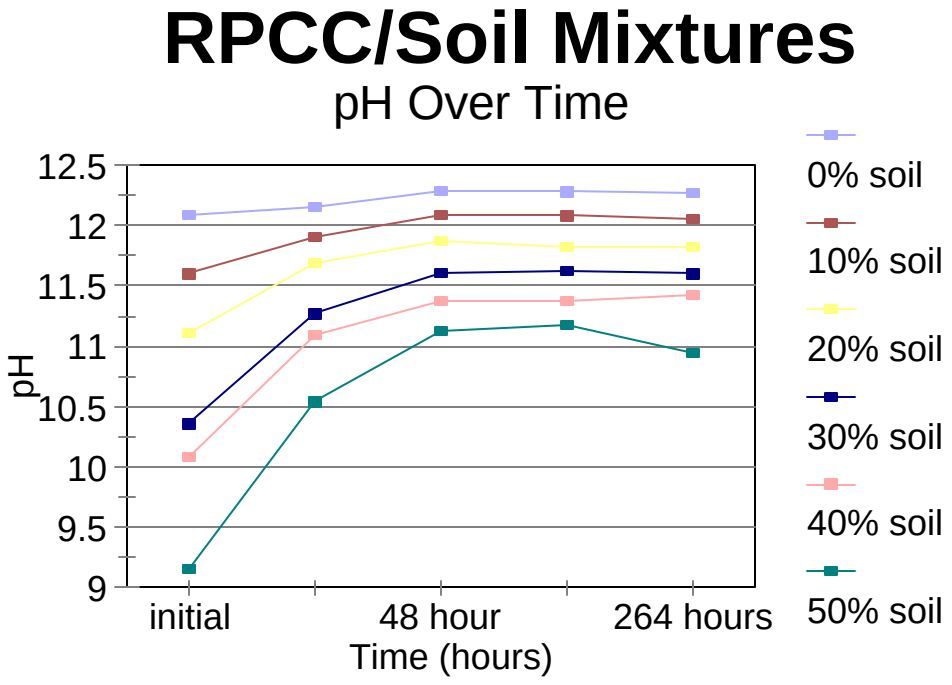


LEVELING EFFECT

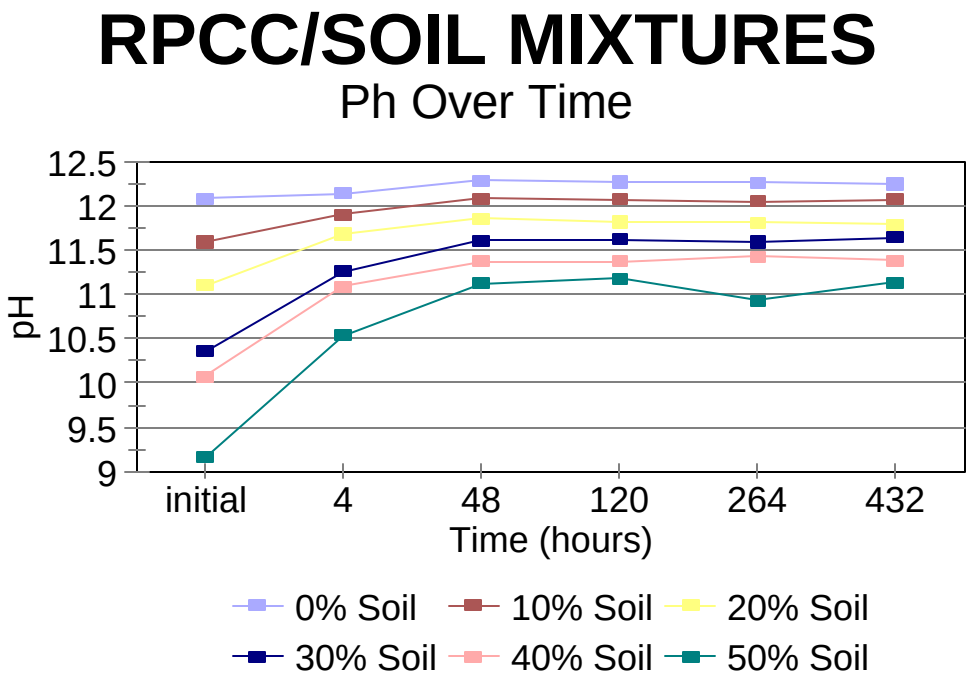
After 120 hours the increase in pH of the mixtures seems to be leveling off. The experiment will continue for another 144 hour period to see how this trend develops.

After 264 hours most of the mixtures remain level. The 50-50% mixture has seen a slight decrease. The experiment will continue for another 7 days to see what happens to the 50% mixture after more time passes.

Chart of the mixtures, minus the 100% soil sample, after 264 hours (11 days)



After 432 hours (18 days) all the mixtures leveled off, including the 50-50% mixture.



Conclusion

The initial pH of the soil used in this, the second part of the experiment, was 5.12. This number is representative of one of the lowest values of soil pH in the state of Ohio. There is a decrease in pH with the increase in the amount of soil in the mixtures. Over time, however, the more soil in the mixture, the greater the increase in pH relative to the initial pH value of the mixture.

After 264 hours (11 days), the pH of all the mixtures leveled off. There was a slight decrease in the pH trend of the 50-50% mixture. After seven more days it was evident that all the mixtures were at a plateau.

In the first part of the experiment the general trend was the decrease of pH with the increase of soil in the mixture and the increase of pH over time. In the second part of the experiment these trends were also seen. In both the first and the second parts of the experiment all the final pH values rose to within a unit or so of the initial pH of the RPCC. The initial pH of the RPCC in the first part of the experiment was 10.19. In the second part of the experiment the initial pH of the RPCC was 12.09.

The final pH values of the mixtures depended on the initial pH of the RPCC and not on the initial pH of the soil.

Even soil of high acidity was not effective in neutralizing the alkalinity of the RPCC enough to lower the pH to an acceptable level. Even the 50-50% mixture would not work to eliminate the high pH runoff that damage roadway drainage systems.

The goal of this experiment to eliminate Tufa, or high pH runoff by the use of RPCC/ soil mixtures cannot be met.