Geotesting News Letter

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Testing of Soil-Lime Mixtures

Richard Haro and Bill Howard of Griffin Lime Company explained their concerns about the inconsistency between labs and test results of lime treated soils. At the time we were working on two lime jobs. One of the jobs was expansion testing on lime treated claystone (fig-1a & b). Preliminary index testing indicated that 8% lime was needed. Our client thought that was high so I suggested that he call Griffin Lime Company. They also thought it was high because 4 to 5% usually does the trick, but the pH testing indicated otherwise. We went ahead with the testing and ended up with 6 to 7% expansion. Our client sent a duplicate sample to another lab for verification. The other lab showed no expansion, so we reran the test with some modifications suggested by the lime company. The retest showed a lower expansion of 4.5% - still too high– so we suggested a third lab. The third lab showed 0.5% expansion so our client really had no choice but to go with the two other lab results. Of course we were very concerned so we did some additional testing. First I went to one of the labs to review their procedures. It was found that both the labs that showed 0 to 0.5% expansion prepared the soil over a #10 sieve. We prepared ours over a #4 sieve. We thought that was most likely the problem so we pursued the theory that the lime did not penetrate the larger claystone clods. We prepared three samples. One -#20, one -#10 and one -#4 sieve size and reran the tests. The -#20 sieve soil-lime mix showed 0.2% expansion. The -#10 mix showed 1.2% and the -#4 showed 4.5%. With that mystery solved we wondered which clod size would more closely duplicate field conditions, (Fig-2), so I asked Rich and Bill of Griffin Lime company if they would take me out to one of their jobs which they graciously agreed to do. It was quite an operation to see. Seven samples of the processed soil-lime mix were taken from different locations. Some modified sieve tests were run to determine the clod size distribution curve. The soil was air dried but not washed to maintain the aggregations of the clods. The soil was sieved for only a couple of minutes so as not to break the clods down. It was found that an average of 50% passed the #4 sieve and 32% passed the #10 sieve. (continued on page 2)

Figure 1a

Expansion Pressure Test

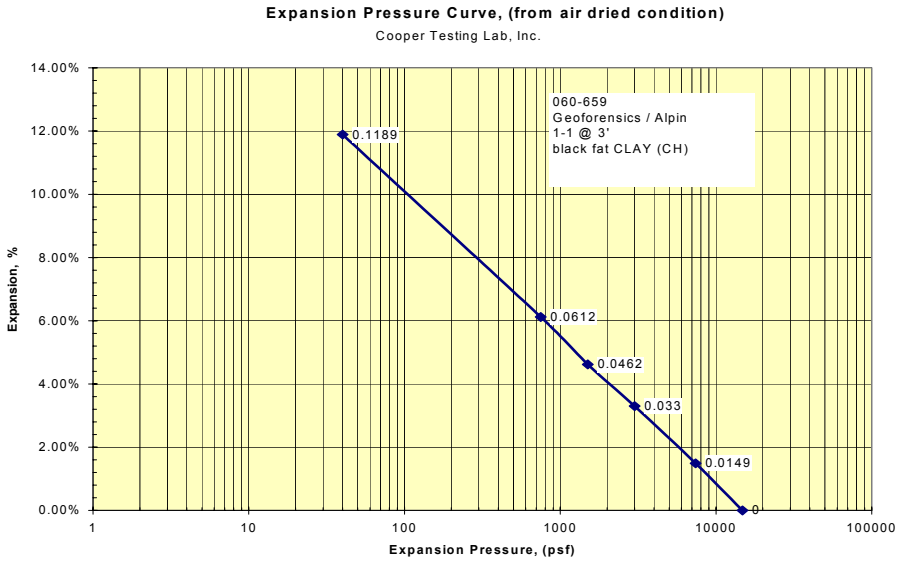

Figure 1b

Inside this issue:

Lime (continued from page one)

From the limited testing that was done it appears that the procedure should be to prepare the soil over nothing smaller than a #4 sieve. The best way to be representative would be to remold a sample with a diameter six times the largest particle size, but that is not always practical. On jobs with claystone make sure the lime company breaks it down during the mix as much as possible. The lime will coat the outside of the clod. Once water is added the lime will become spent after it hydrates without ever affecting the majority of the inside of the clod. If the claystone is ever exposed to water it will expand. It would be interesting to take some undisturbed samples of lime treated claystone soil shortly after compaction and run some expansion tests. We may do this in the future but until then we strongly suggest using the #4 sieve in the lab. It is more conservative than using a smaller sieve and it will give the engineer a heads up by showing some expansion. I am amazed at the difference in lab test results (especially expansion tests) due to the sieve size used during preparation. The idea should be to duplicate field conditions. We think that using the #4 sieve will help to accomplish that goal.

This problem could not have been more timely since we were in the process of helping Griffin Lime Company write a manual on testing procedures for soil-lime mixtures. The whole thing became quite a time consuming research project, (at our cost). My employees are always upbraiding me for that. This is actually not uncommon for us. We always seem to be researching something. *Special thanks goes to the other labs and Griffin Lime Company. Everyone worked together freely exchanging information in the spirit of scientific research. It was fun!*

Average Clod Size Distribution Curve

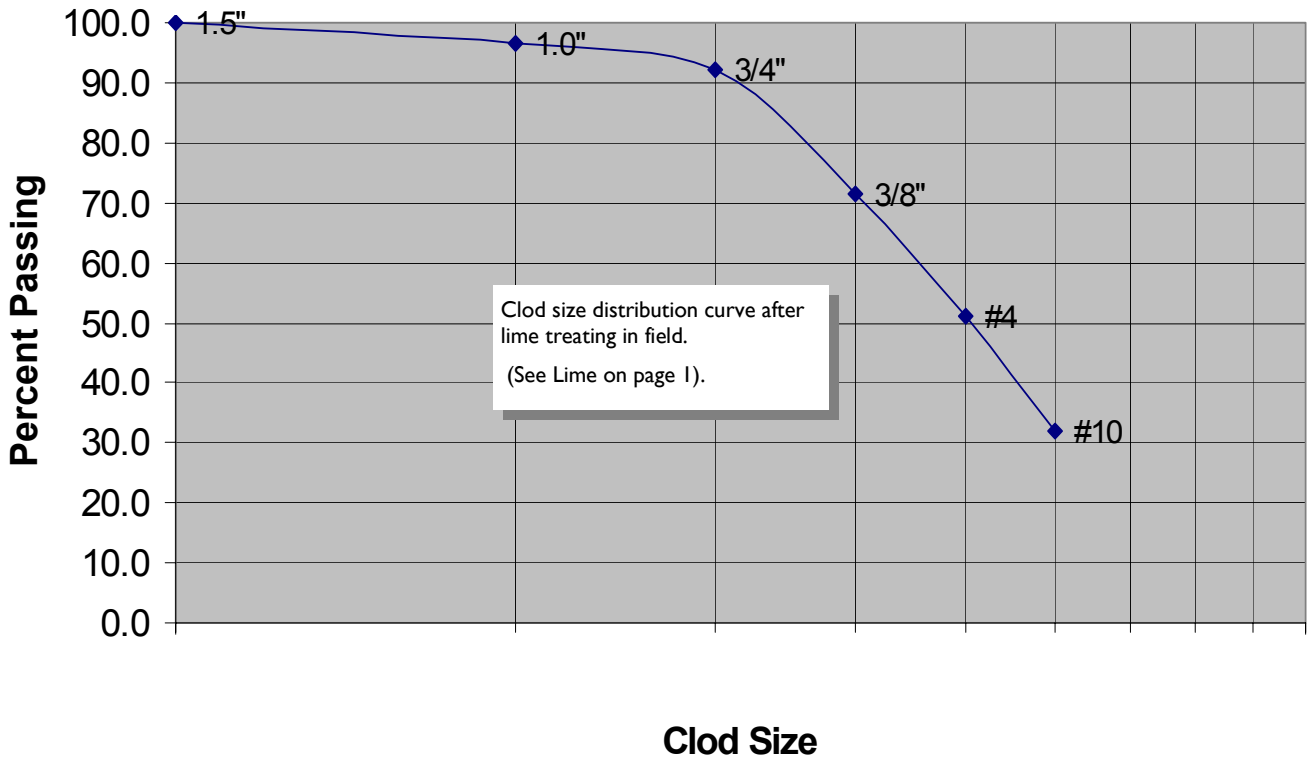

Figure 2

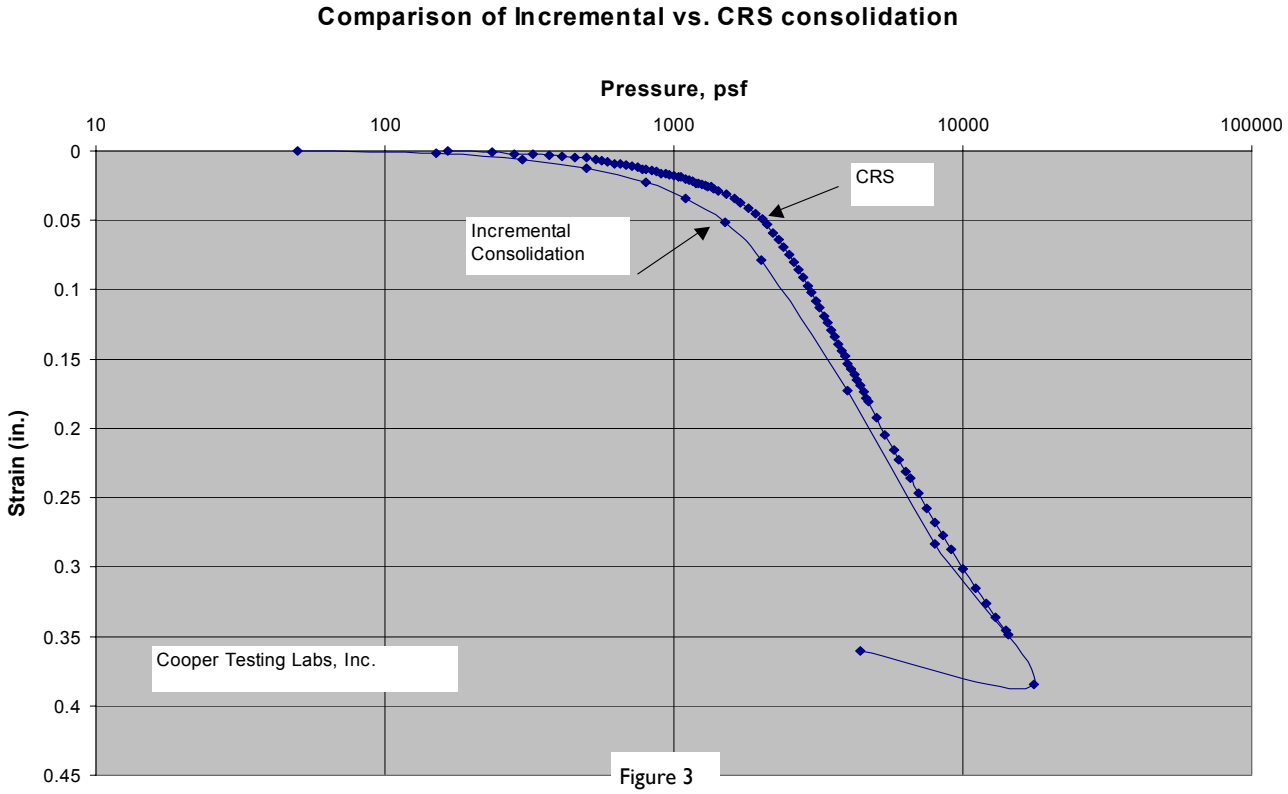

Figure 3

We have been suggesting the constant rate of strain consolidation test. It has been very slow to catch on. Many engineers do not know very much about the test, even though it has been around for over 30 years. Above is a comparison of the two tests. A six inch section near the tip of a pitcher tube also known as a shelby tube or pitcher barrel was cut off with a tube cutter and extruded. Two one inch specimens were trimmed from that block of soil. One was tested in the incremental and the other in the CRS. As shown above the CRS test showed less disturbance apparent by the sharper bend at P_c. Large loads applied on the incremental test disturb the sample by over-stressing it. The CRS test applies a slow constant rate of loading which is also more representative of what happens in the field. C_v measurements are continuous rather than one point per load. The pore-pressure is measured at the bottom of the sample so that the effective vertical stress can be plotted. The load has to be left on the incremental test until the excess pore-pressure dissipates (typically 24 hours) to insure that the effective stress is known. If the technician loads an incremental consol too soon the actual load is unknown because it is somewhere between the total and effective stress. The CRS test can be completed in two days instead of two weeks for the incremental. We are offering the CRS test for $300 which is $60 more than the incremental test.

CRS & Continuous Plot of C_v

As shown in figure 5 the continuous plot of C_v is measured during the constant rate of strain consolidation test. It is very interesting that the plot of C_v crosses at the break (P_c) of the Stress-Strain curve. It almost always crosses at or just beyond the break. One could question: "is the point at which it crosses the Stress-Strain curve the maximum past pressure?" One problem with the test is it is sometimes difficult to get a good seal between the soil and ring. A positive pore pressure response is imperative. (see Fig #4)

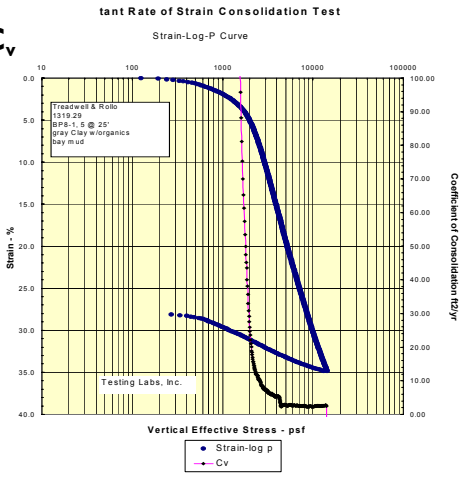

Figure 4

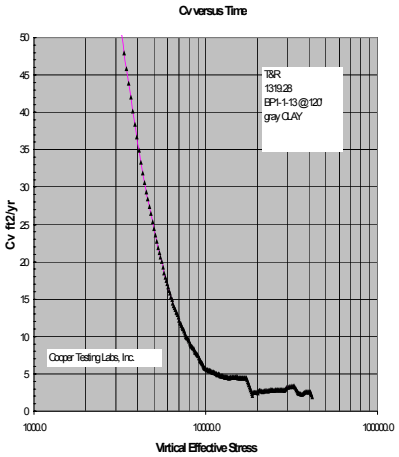

Figure 5

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What's new at Cooper Testing Labs ?

We have been working toward one major goal from two lines of attack. That goal is a better turn-around time with the same or even better accuracy. How can that be done? More people and more automated equipment. We have been successful in both strategies. We opened a new lab in Petaluma and hired two more technicians. We also automated most of our older equipment and bought new automated equipment. The amount of testing that we do in one week would have taken three to four weeks a couple of years ago. The accuracy of the test results is better because of computer automation and/or computer monitored equipment. All the equipment is on the same network that the computers in the front offices are on. We have a virtual private network between the Petaluma and Mountain View offices and my home. I can access any computer and take control of it using PC Anywhere software. The other morning I was on the phone to Al in the Petaluma lab while taking control of the Petaluma triaxial computer to show Al how to configure a test. All the triaxial, direct shear and consolidation test files are down-loaded to the appropriate file-folder on the server and retrieved by the software on my office computer, reduced and printed out. Before the test report is printed it is checked by me against the hand readings that are taken on all the tests to check the computers. I wouldn't trust a computer nearly as far as I could throw one and I have thrown one across the lab. I like to keep them in fear! Once I am satisfied that the data is accurate the report is printed out and faxed to the client. Once a week all the testing jobs are sent out with the bill to the client. All the data from both labs is checked by me and only me before it goes out. The accuracy of the testing is the most important thing. If I do not like the looks of a test result the procedure is reviewed by myself with the technician and lab manager. If there is any doubt about the accuracy the test is rerun. Many times we will split the sample and have two different technicians perform the retest so that we can also check the consistency between the technicians. We also participate in the AASHTO sample reference program.