Soil Stabilization Methods Webinar Q & A
July 18, 2023

1. Being a permanent change, does the strength (CBR) of a CSS remain stable over the long term, 20 years?
Yes, it does. Even with the low strengths of CSS (100 to 300 psi), its increased moisture resistance keeps water out and maintains strength when wet, reduces the potential for pumping of subgrade soils, provides resistance to damage from freeze/thaw cycles, and continues to gain strength as it ages. CSS over the years will retain its strength if not gain a little additional strength.
Missouri

2. Where did you get the stacked sieve image?
The image has appeared in numerous presentations for many years, but I believe the original reference can be found here ➔ https://www.tpub.com/eqopbas/223.htm.
Missouri

3. Can we use the modified proctor method for soils-cement?
Yes. The modified Proctor method is acceptable for testing soil-cement material. However, the standard Proctor testing equipment is much more widely available and more familiar to soil testing laboratories.
Perú

4. Could you please provide an outline of what requirements there might be for test sections?
Prior to the start of CSS production, the contractor should construct a control strip to verify that the construction process meets the specified requirements. The control strip shall be a minimum of 300 feet (90 meters) in length and adequate in size for the contractor to:

1) Demonstrate that the equipment, materials, personnel, and processes proposed can produce a CSS layer that conforms to the specifications.
2) Adjust the rates for cement and water recommended for the CSS material.
3) Determine the roller pattern necessary to obtain the density requirements.
4) Obtain representative samples for any required moisture, density, and compressive strength testing.

CSS operations can begin if the contractor's equipment and process meet the specifications. If the specifications are not achieved, CSS operations should be suspended, and the contractor should submit a plan for corrective action. Upon acceptance of the control strip by the engineer, the contractor should use the same equipment, materials, and construction methods for the remainder of the CSS operations.
Illinois

5. What is the criteria for testing UCS for a already designed road by coring??
Coring of cement-stabilized materials that have a 7-day UCS of less than 300 psi (2.1 MPa) is not recommended as this low strength can lead to excessive breakage in extruded cores. Coring of soil-cement materials greater than 300 psi (2.1 MPa) should be performed at a low speed and dry or using the minimum amount of water at a low flow rate. Ensuring that the coring apparatus is level, stable, and unmoving is critical. In the laboratory, both ends of the extruded core should be sulfur-capped to establish a level surface for compression testing.
INDIA

6. What should be the cement content and UCS of 7 day for CTSB?? Thank you so much for this wonderful webinar :) LOVE FROM INDIA!!
Typical seven-day UCS for cement-treated base (CTB) layers range from 300 to 600 psi (2.1 to 4.1 MPa). This strength range can be obtained by using 2 to 6 percent portland cement depending on the soils/aggregates being stabilized. All our love back to you!

INDIA

7. Is it common for the contractor to target 1-2% above optimum moisture content during construction to account for moisture loss during the placing and compaction operations?
Yes, this is a common practice. The approximate percentage of mixing water required is equal to the difference between the laboratory-determined OMC and the in-place moisture content of the CSS material. About two percent additional moisture must be added to account for the cement added to the soil and for evaporation that normally occurs during CSS processing.
South Carolina

8. Is it possible to make strength samples during construction or take cores after construction to test for compressive strength or do you have to go by density only for acceptance?
It is possible to both make samples and core completed CSS in the field for UCS testing. However, samples and cores are different - cores represent the in-place CSS strength and are difficult to obtain (see the answer to Question #5) while samples represent the quality of the CSS constructed. The way soil reacts with cement is determined by simple laboratory tests to determine the minimum cement content required to produce the desired CSS in terms of UCS and durability requirements, the OMC necessary to sufficiently compact the CSS, and the MDD to which the CSS must be compacted during construction. During construction, field tests are made to see that these laboratory requirements are being met. Field testing ensures that the mixture will have strength and long-term durability. No guesswork is involved.
Illinois

9. Is there a way to control compaction levels of the soil BEYOND the stabilized soil?
The only way to truly control the compaction levels beyond (below) the CSS layer is to expose this material prior to CSS construction through excavation in order to compact it and check its density. The CSS material can then be constructed on top of this material. A dynamic cone penetrometer (DCP) can rapidly and inexpensively measure the strength and deformation properties of a subgrade to a depth of approximately 4 ft (1.2 m), which might provide the soil support information desired.
Lithuania

10. There are situations, where the soil needs to be strengthened in urban areas (streets) with many utilities below. What are the pros of stabilizing the soil instead of using geosynthetics?
Containing poor soils using fabrics or other geotextiles is a workable solution for poor subgrade soils; however, this approach does not address the poor soils themselves. CSS is an economical, fast, and sustainable solution to several soil problems encountered before or during construction. Cement treatment can thus help reduce or maintain project timelines and budgets and minimize the impacts of poor soil on pavement design in both rural and urban environments.
Lithuania

11. I've also struggled with optimum moisture requirements for cement stabilization. A proctor is run on treated soil. This gives us OMC post-cement application. How do we then know what the moisture content of the soil should be before cement application? The untreated OMC doesn't seem relevant since cement is going to be added, thus changing our curve. Do we need to do a little rough math using the OMC of the treated sample and determine the impact of adding dry material (whatever % of cement)?
The moisture content of the untreated soil should be near the determined OMC of the CSS material as this will help eliminate the need to drastically alter the moisture content of the untreated soils before cement is applied. If the untreated subgrade soil is more than 3% above the CSS OMC, the material should be aerated and allowed to dry back. If the untreated subgrade soil is below the CSS OMC, water should be added. Having the untreated

soils as close to the CSS OMC as possible will make it easier to keep the desired moisture content constant.
Iowa

12. Do you know of research on the durability of CSS, say +5, +10 years, +20 years, to freeze-thaw cycles?
The following link will take you to a PDF titled "Performance of Cement-Modified Soils: A Follow-Up Report" that looks at cement-treated subgrade soils in Oklahoma (20-inch frost line depth). Numerous in situ and cement-treated subgrade soils were tested in 1938 and again in 1983 (45 years later) which showed a continued improvement in the PI reduction of the soils.
https://www.cement.org/docs/default-source/cement-concrete-applications/rp281.pdf?sfvrsn=9e56fdbf_2
Iowa

13. Is there a recommended timeframe before CSS treated area is opened back up to construction traffic? Thank you for the information! Much appreciated!
Completed portions of CSS can be opened immediately to low-speed local traffic and to construction equipment, provided any curing operations are not impacted, and provided the CSS is sufficiently stable to resist marring or permanent deformation. A proof roll with equipment such as a loaded water truck can be used to verify that the grade is firm, unyielding, and ready for light traffic.
Iowa

14. Nice presentation. Thank you.
Thank you very much. Please let us know if we can be of any further assistance to you.
Minnesota

15. Plastic clays/elastic silts can be stabilized with cement, but typically requires a dual application with lime first to modify the behaviour to a more friable soil, then add the cement to stabilize with some strength.
That is correct. Cement is widely recognized as a reliable soil stabilizer that brings strength and long-lasting resiliency to pavement subgrades. However, extremely high PI soils, when wet, are problematic for mixing with cement alone. Blending lime first then adding cement for immediate strength is proving to be both a reliable and economical method to guarantee success for pavement projects.
Maryland

16. A thicker section also drives the moisture/frost effect deeper into the ground so it is ultimately better for a climate subjected to freeze/thaw cycles.
That is correct. For frost heave to occur the soil must be frost-susceptible, water must be available, and temperatures must be below freezing. Eliminate one of these three factors and frost heave ceases. CSS turns an in-place soil subgrade into more of a granular soil material which makes the soil less frost-susceptible.
Maryland

17. Why are you doing Atterberg limits with 3 cement contents for sands?
Step 4 of the CSS mix design process is the determination of Atterberg limits for 3 different cement content samples. However, Step 1 is to classify the soil being treated. If the classification procedure identified the soils as sands, then there would be no need in determining the Atterberg limits which are for fine-grained soils such as clay. The importance of geotechnical oversight at the beginning of a project, during the mix design stage, and during construction will ensure that a CSS project meets its intended purpose.
Maryland

18. Molding samples ASAP is due to initiation of hydration of the cement when it comes in contact with moisture in soil.

That is correct. Moisture in a CSS sample is present to both aid in compaction and to hydrate the cement. Molding samples immediately after cement is incorporated ensures that there is enough moisture present to achieve both aims.
Maryland

19. It's not practical for a contractor to change the cement spread rate along a road to accommodate changes in the materials so the adding of 0.5 to 1% is more of a cushion to maintain consistent strength and durability of the mixture.
In CSS construction, it is a common practice to increase the cement content determined by the mix design process by 0.5 to 1.0 percent to accommodate construction uncertainties – laboratory conditions do not always mirror field conditions. However, the mix design should account for variances in material types throughout the length of the project. It is recommended that the mix design be changed whenever the CSS material types significantly change. A thorough sampling of the subgrade soils to be treated will assist in determining if multiple mix designs are required over the length of the project.
Maryland

20. Can the cement slurry be injected into the mixer drum?
Yes, it can. Cement slurry can be introduced into the mixing chamber of the reclaimer through a spray bar.
Maryland

21. Is compaction to 95% of standard or modified proctor?
Compaction density is typically determined through the standard Proctor test method (ASTM D558). The ASTM D558 test method is a common (as well as inexpensive) procedure for most construction testing labs and can be performed in either the laboratory or the field.
Maryland

22. I have seen contractor apply the asphalt base course right after mixing, compacting and shaping to serve as a moisture loss barrier - seems like it would not be a good idea since the heat of the asphalt mix could evaporate the moisture in the surface of the soil-cement mix.
Remember that CSS is a stabilization treatment for poor subgrade soils. Subsequent subbase and base layers can be placed at any time after finishing is completed, as long as the CSS is sufficiently stable to support the required construction equipment without permanent distortion or marring of the surface. This also applies to surface layers including chip seal, HMA, and concrete.
Maryland

23. How does the roller compact to depths of 2 ft? Seems like the bottom of the layer would not be as compacted as the surface?
While there are some compaction equipment that can achieve the required density as deep as 24 inches, the majority of compaction equipment operates in the 12- to 18-inch depth range. When greater depths are required to be densified, the soils are compacted in layers in order to ensure adequate density throughout.
Maryland

24. Does soil-cement base materials contribute to definition of "perpetual pavement"?
The term “perpetual pavement” refers to an asphalt pavement that is built to last for 50 years or longer with minimal maintenance. However, portland cement has been used to stabilize soils since the early 1900s with the first engineered use in South Carolina back in 1935 that is still in place and performing well. The longevity of soil-cement base layers certainly qualifies them as enduring or perpetual!
Maryland

25. Can PLC cement be used interchangeably with Type I/II cement in this application?
Portland-Limestone Cement (PLC) can be used in CSS applications but testing is always recommended to ensure that the cement content selected results in the target UCS of the CSS material. In a great deal of cases, substituting PLC for Type I/II is a one-to-one substitution but testing is always advised.
Maryland

26. Stabilized base materials are more resilient to inundation from flood situations - pavement recovers quicker
Absolutely! Moisture intrusion can destroy unstabilized pavement layers, but not when portland cement is used to bind the materials. CSS forms a moisture-resistant subgrade layer that keeps water out and maintains higher levels of strength, even when saturated, thus reducing the potential for pumping of subgrade soils.
Maryland

27. Can you provide a link to the CSS document?
https://intrans.iastate.edu/app/uploads/2020/05/guide_to_CSS.pdf
Maryland

28. Very good presentation today. Is the initial pulverizing required prior to application of cement or can you apply the cement to the roadbed first and then pulverize and add moisture all in one mixing pass? If the cement treatment proceeds a bituminous c
Glad you enjoyed the presentation. Initial pulverization is an optional requirement. Before cement is applied to the subgrade, initial pulverization using a roadway reclaimer may be required to the full depth and width of mixing to help ensure uniform distribution, especially for cohesive soils such as silty clays and clays. With the right equipment and the right soil types, cement may be applied directly onto the subgrade and all pulverization and mixing operations completed in one pass.
Florida

29. Will this presentation be available to share?
Yes. All of the Tech Tuesday webinars can be viewed on the CP Tech Resources web page here: https://cptechcenter.org/webinars-and-videos/.
Minnesota

30.Where do you typically see these methods used? rural, urban, parking lots?
CSS is more commonly used for pavement subgrades (low volume roadways, residential streets, medium to high-volume roads, State routes, interstate highways, airport runways and taxiways, and parking lots) and for foundations (site work). These applications can be both rural and urban.
Minnesota

31. Is there a list of contractors that perform this process in the Iowa/Minnesota region?
The Aspahalt Recycling and Reclaiming Association (ARRA), which is also involved with soil stabilization, has a site to search for such contractors by state ➔ https://www.arra.org/search/custom.asp?id=4584.
Minnesota

32. Will this presentation be recorded? There was difficulity in connecting at the beginning.
Yes. All of the Tech Tuesday webinars can be viewed on the CP Tech Resources web page here: https://cptechcenter.org/webinars-and-videos/.
North Carolina