Improving Soil-Cement Base Stabilization with Polymer Sealants

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Cement stabilized soil, or soil-cement, is a compacted mixture of soil/aggregate, cement, and water. It is widely used all around the world as a pavement base for roads, mostly due to its low initial cost and good compressive strength properties. In some cases, a thin bituminous surface is applied atop the cement-stabilized base for a complete, low-profile pavement.

There are pros and cons associated with the usage of soil-cement bases. The most important property of base and sub-base layers is considered to be their compressive strength. The value of this property is directly related to the amount of stabilizing agent being used, i.e. more stabilizing agent leads to higher compressive strengths being achieved. Yet, this gain in the compressive strength comes with a cost in shear stress resistance, as shear strengths drastically decrease when enough cement stabilization is used, resulting in more brittle stabilized soil. Before any construction can take place, laboratory tests have to be performed in order to determine the proper cement content, compaction, and water requirements for the specific soil to be used in constructing the stabilized soil structure. Tests should continue throughout construction to verify that the target performance requirements are being met.

Soil-cement bases have many advantages, such as that they can be utilized as a method for salvaging, reclaiming and strengthening granular-base pavements. Granular and waste materials from quarries and gravel pits can be used in soil-cement bases which give dramatically decreased handling and hauling costs. Such efficient use of materials results in the cost of soil-cement comparing favorably with that of other granular-base pavement methods. Soil-cement is a uniformly rigid layer which allows for the vehicular load to be spread over a wider area. This allows for a thinner soil-cement layer if compared to granular bases carrying the same traffic load. Such slab-like characteristics cannot be found in other granular bases. Soil-cement structures can remain in good service levels for low maintenance costs.

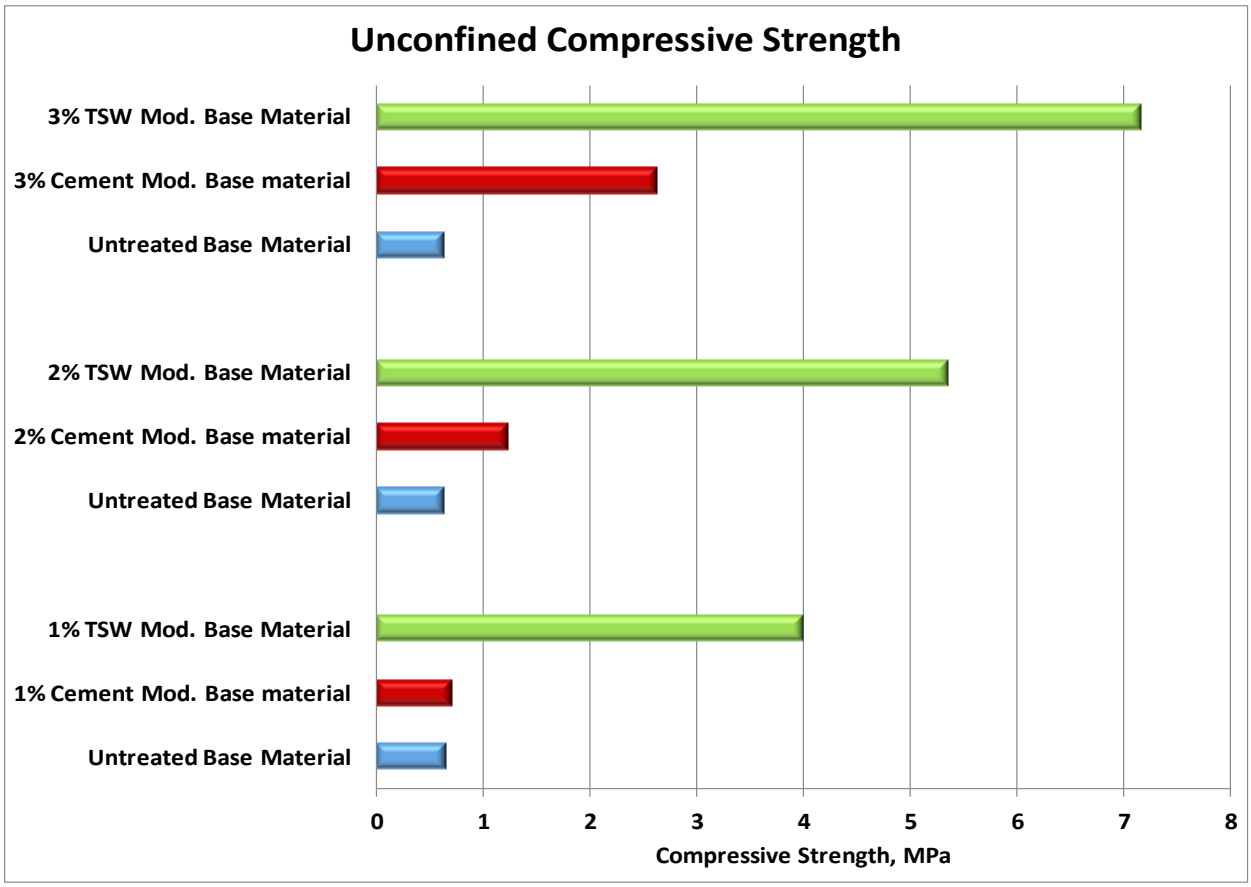
Despite the numerous benefits of soil-cement pavements, and it being used all over the country, concerns about shear stress resistance and susceptibility to cracking often discourage more extensive use of this method in paving operations. In order to avoid brittle failure, different DOTs across the country limit the allowed percentage of cement stabilizing agents used in mixes. As cement content increase, the strength and stiffness of the soil also increase. However, stress-strain curves are highly dependent on a structure's stiffness. Experimental results indicate that as the stabilizing agent increases, the strength and the stiffness of the material increase. However, this strength comes at the expense of flexibility as the rate of softening decrease with increasing confining pressure. In response to these drawbacks, investigation has begun into polymer-based stabilization as a method for achieving soil-cement strength without sacrificing shear stress resistance.

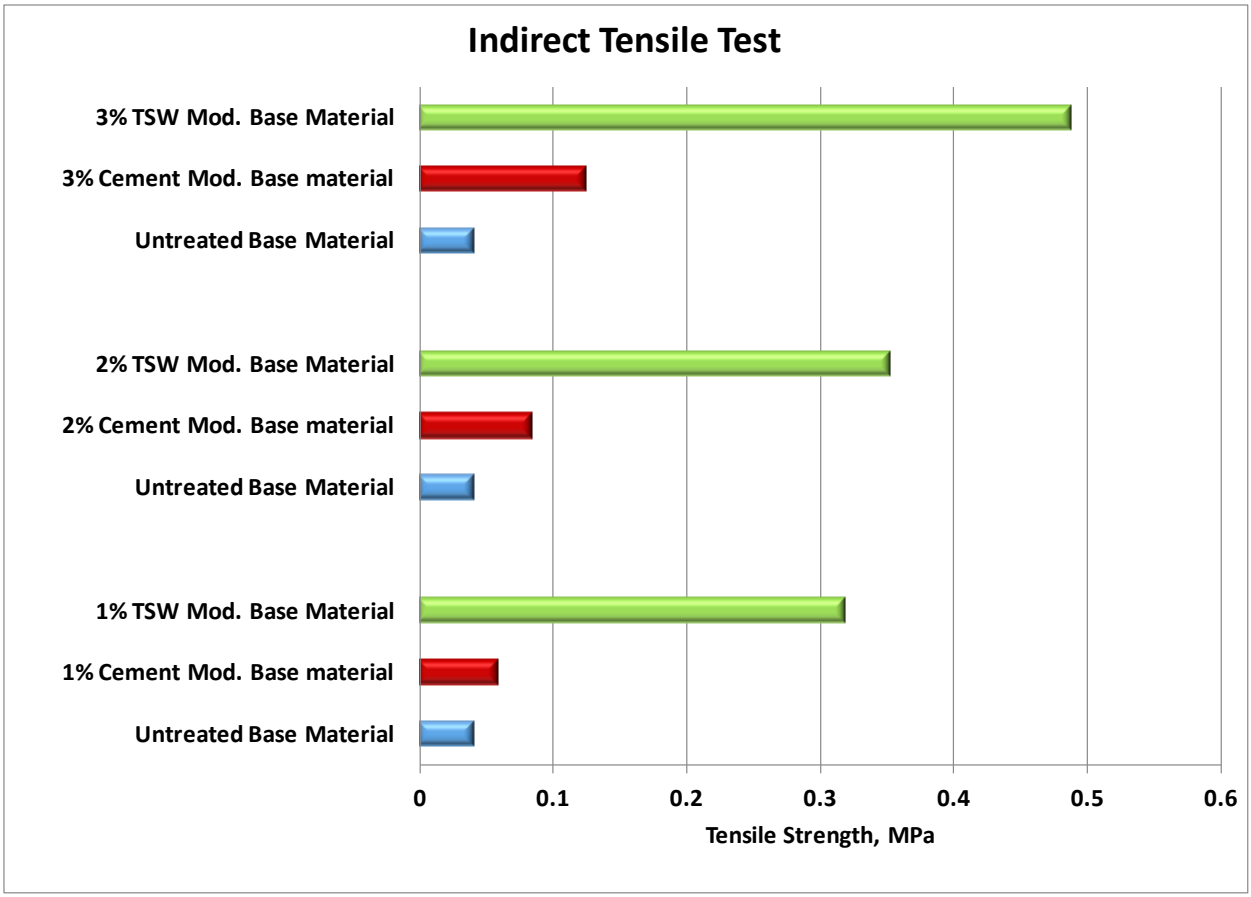
Regardless of whether the soil-cement is mixed in-place or at a mixing plant, the same compaction and curing procedures are used. The steps involved in base layer construction are the same for cement based agents as for polymer ones:

1. spreading cement – proper quantity of agent spread on the in-place soil material

2. mixing – agent, soil material, and water are mixed thoroughly by any type of mixing machine
3. compaction – mixture is tightly compacted to obtain maximum benefit from the agent
4. curing – prevents evaporation of water to ensure maximum strength development

As polymer-based sealants become more and more common in the paving industry, pavement engineers are discovering new methods for utilizing these relatively new materials. While cement is used as a stabilizing agent in soil-cement largely due to its good compressive strength values, a recent investigation completed on Top Seal White (TSW) at the University of Texas at Austin has revealed that using the same amount of a TSW polymer-based stabilization agent produces compressive strength values that dramatically outperform cement-stabilized bases. Another parameter of interest of soil-cement bases is the strain corresponding to the maximum applied load (stress). Cement materials tend to lead to lower achievable shear stress resistance when compressive strengths values increase. This can lead to brittle failure of the layer. TSW has proved it can achieve higher compresive strengths, while maintaining the same shear stress resistance level. This allows for the necessary flexibility in the base and sub-base layers. For the same percentage of stabilizing agent used in a mixture, TSW achieves higher compressive and tensile strengths. The gain in strength for TSW is higher at 1% than the strength of a 3% cement mixture.





This comparative investigation reveals that TSW polymer-stabilized bases provide the same strong, slab-like characteristics of soil-cement, while also contributing to its flexibility, and thus making it more resistant to cracking. When using polymer-based stabilization, shear stress resistance is not sacrificed for high compressive strength values. Results from this study suggest that polymer-stabilization can be considered a base stabilization method that provides all the benefits of soil-cement discussed above, while at the same time mitigating the brittle behavior drawbacks of utilizing cement base stabilization.