Engineering

UPDATE©

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From Research to Practice

Some earthwork construction claims result from certain pay items containing incidental tasks with no quantification relative to this work effort but are still required under the contract.

An example of this is when the contractor is required to maintain the subgrade. Maintenance depends on the compatibility plans and specifications to the subgrade soil. The contractor must then assume based on the contract documents how much effort this will take. If he is wrong, it will impact his associated costs and the added subgrade maintenance can result in scheduling delays and impact other parts of the construction activity.

Pavement work is fairly sensitive to these issues as design usually does not include an analysis of subgrade stability conditions relative to construction loads, site drawings, and expected groundwater or precipitation prior to paving. Should the contractor have anticipated problems where: a. they were not explicitly addressed in geotechnical report, plans, and specifications; or b. where boring logs and geotechnical data are only given and the contractor is left to interpret it himself?

I will leave you to fill in your own answers.

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SOIL PROVIDES POOR ROAD CONSTRUCTION SUPPORT

The new concrete pavement for an airport facility in Memphis, TN had an abnormal and alarming amount of cracking. Also, there were significant difficulties during construction in preparing the subgrade. As a result of these construction and performance problems, MEA was requested to conduct a forensic geotechnical investigation.

Loess (a wind-blown soil deposit) was the immediate subgrade support for the about 16 acres of new pavement. Upon visual examination, this loess subgrade appeared to be moist and a typical loess soil with significant amount of silt. In the lab, however, when the above loessal soils were tested across the typically recommended and specified compaction ranges, this soil was found to have extremely detrimental characteristics for pavement support and construction. In addition to having low bearing strength at both modified and standard Proctor compaction limits, there was also significant swell. Also, the soaked bearing strengths for this soil were always lower than the recommended range for pavement design.

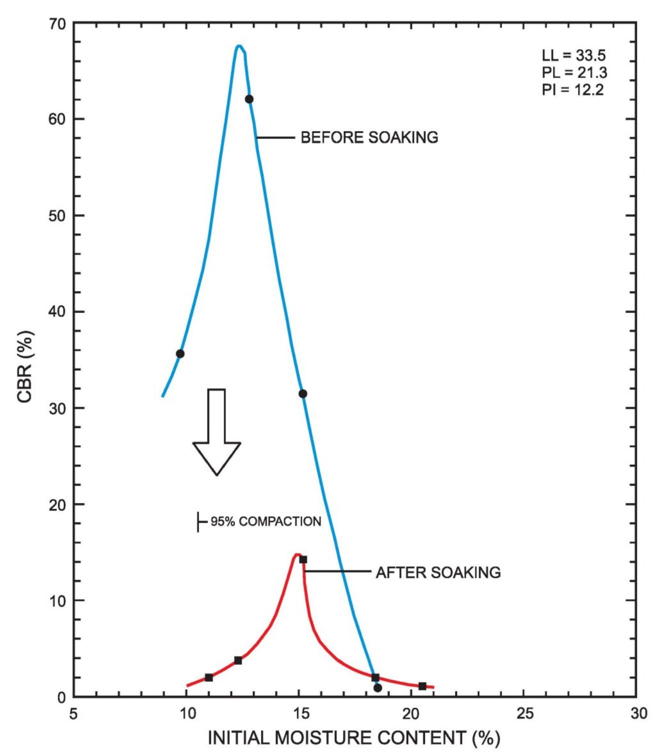

FIGURE 1 UNSOAKED AND SOAKED CBR VALUES VERSUS MOISTURE CONTENT AT STANDARD COMPACTION FOR SUBGRADE SOIL

Without testing at the compaction limits of $\pm$95%, the results can be deceiving and produce exceedingly high soaked CBR values with no evidence of the soil's swell potential. This was especially the case with regard to this loess. From soaked bearing strength testing it was found that this soil had an egregious sensitivity to the compacted moisture-density where the peak strength was up to 10.9-fold greater than at the 95% standard compaction limits (9.4 ave). For example, see Figure 1 which depicts the drop in strength when the soils became soaked.

The very bad engineering properties of these subgrade soils can be attributed to the significant amount of smectite present in the loess. From X-ray diffraction tests the <1 μm fraction of the loess was found to have clay consisting of an average 40% smectite. Clay minerals are known for their dramatic expansion with water absorption.

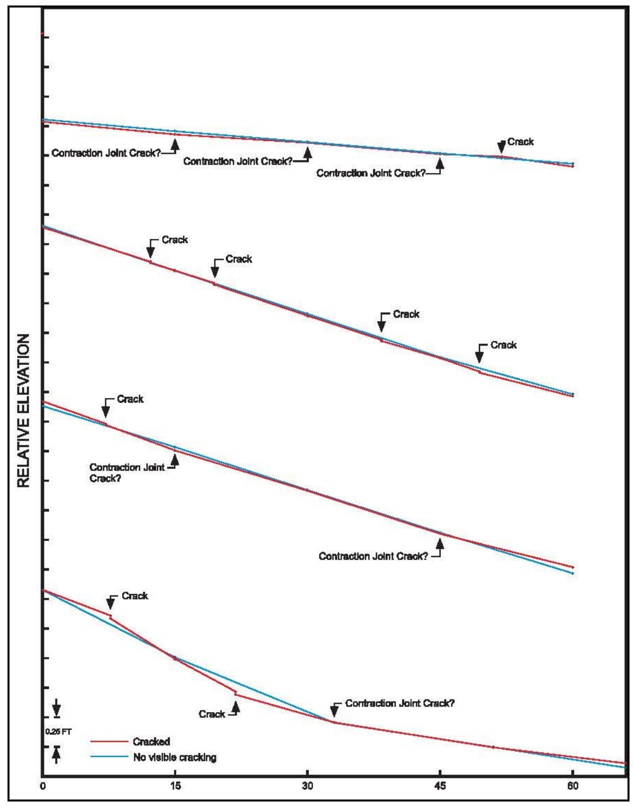

FIGURE 2 COMPARISON OF ELEVATION PROFILES ACROSS DAMAGED AND NEARBY UNDAMAGED CONCRETE PAVEMENT SECTIONS

The use of a subgrade soil with this amount of smectite resulted in a myriad of construction difficulties. Shortly after the pavement was placed, significant damage was evident. The pavement cracking became significantly worse in less than a year's time. Differential surface elevations measured across the concrete pavement demonstrates the effects of the swelling/shrinking and softening process of the pavement subgrade which is accompanied by soil moisture change (see Figure 2). Also, the soft to hard subgrade stiffness determined from falling weight deflectometer tests in correspondingly wet and slightly moist areas validated this soil behavior.

Classification of the swell potential of soils based merely on plasticity index values could be misleading. In fact, pavement construction soils classified by plasticity with even a low to medium swell potential could have a significant impact on the final product. The effect of swell on damage is a function of structure type and the construction activities. Soil swell also causes changes in grades during construction—and if unsuspected—results in thinner pavement courses than specified, not to mention the future performance problems of the pavement.

Other Engineering UPDATES of Interest:

UPDATE 12: Investigation of a Roadway Failure

UPDATE 15: Asphalt Quality Investigation

UPDATE 20: Investigation of Pavement Performance

ABOUT MEA: Marino Engineering Associates, Inc. focuses on engineering research, practice and expert evaluations and is licensed in 24 states in the U.S. Our projects primarily have an emphasis on Geotechnical Engineering, however, we also have significant experience in projects involving transportation, subsidence engineering, laboratory testing, training, and geophysical exploration. Gennaro G. Marino, Ph.D., P.E., D.GE is president and principal engineer of Marino Engineering Associates, Inc., and has been a licensed professional engineer since 1984. To obtain additional information on MEA, one can also visit our website at www.meacorporation.com.

FOR MORE INFORMATION: There is a significant amount of additional information that is available on the above subject. For more information, please contact Dr. Marino at the address listed below.

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