SOIL COMPACTION SUPERVISOR

SOLUTIONS THAT LAST

M-B-W

SOIL COMPACTION SUPERVISOR (SCS)

If ever there was a need for a "fresh approach," it is in the area of small excavation reinstatement. Municipalities are frustrated with pavement failure over and around utility excavations. Utilities decry the high cost of complying with backfilling specifications that vary from municipality to municipality. Research efforts directed to improving the reinstatement process have failed to result in a cost effective, uniform approach to the problem.

MBW's approach begins with two observations.

1. Backfilling specifications for small excavations have always emphasized achieving the best results possible within the confines of the excavation. This can be problematic when municipalities require removal of excavated spoil and replacement with a substitute backfill material. While the imported backfill may be easier to compact than the original spoil, or may offer superior engineering properties, to the extent that imported backfill is dissimilar to soil surrounding the excavation, sub-grade uniformity is compromised.

   Uniformity in subgrade performance is a principle engineering objective in pavement applications.

   For reasons of uniformity, the soil coming out of an excavation is the preferred material for reinstatement purposes. Gradation is identical to soil surrounding the excavation. Spoil reinstatement provides the highest probability of achieving uniform sub-base performance.

2. Municipal pre-occupation with end result testing has been counter-productive in terms of performance. When it comes to small excavations, end result testing is frequently skewed, often misleading, and the testing process defeated by common violations of protocol. **Protocol violation is the chief cause of earthwork failure in small excavations.**

How does SCS technology address the troublesome issues of protocol violation and quality control?

- The SCS is seismic technology based on the principle that a soil's pressure wave transmission efficiency improves as the soil becomes stiffer. In practice, the SCS monitors amplitude growth of pressure waves imparted by compaction tools during the compaction process. The SCS determines when continuing compaction activity has reached a point of diminished returns relative to increasing wave amplitude, i.e., has ceased providing meaningful improvement in soil stiffness (force/deflection). At that point, the SCS gives a visual signal to terminate compaction activity and documents whether or not its instructions were followed. **The SCS monitors, manages, and documents performance relative to the compaction effort.**

- SCS results are neither surface measurements, nor the product of averaging. The SCS advises the crew to stop compaction only when compaction activity no longer results in engineering benefit anywhere in the vertical profile of a lift. SCS results provide a direct index of achievable soil stiffness and corresponding density. Given the conditions of compaction, a better result cannot be achieved.

- The SCS documents the number of lifts/excavation, time of compaction/lift, type of compactor used on a given lift and whether or not the crew followed SCS instructions. In so doing, the SCS documents performance relative to protocol. Performance can be reviewed. Accountability is enhanced. Data can be archived for analytical purposes in the event of reinstatement failure.

- Because SCS technology encourages use of spoil as backfill material, manages the compaction process, monitors protocol conformance, and brings each lift to the apex of the stiffness curve, uniformity in sub-grade performance is achieved in and around the excavation.

ELIMINATES GUESS WORK IN SOIL COMPACTION

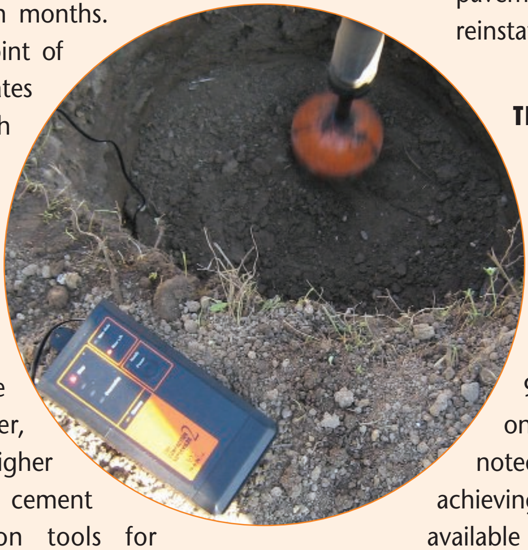
PRACTICALITY:

In practical terms, the SCS is ideal for use by municipal and utility crews. Little training is required. The crew needs only to turn the meter "ON" and follow SCS instructions. Green lights indicate that compaction must be continued on a given lift. A Red light indicates that compaction should be terminated. Data downloads automatically. The SCS turns itself off after completion of each lift.

COST REDUCTION POTENTIAL:

- Some municipalities specify importation of select backfill for use in small excavations. Costs of removing spoil and importing a substitute material are high. To the extent that the imported material's gradation and engineering properties differ from the soil surrounding the excavation, the probability of producing stress concentrations, variable deflection rates and pavement failures at the periphery of the excavation are increased. Reinstatement of the original spoil eliminates the cost of importing fill and provides an identical match to soils surrounding the excavation. Properly backfilled spoil offers the highest probability of achieving uniform sub-grade performance.

- Still other municipalities specify replacement of spoil with "flowable fill". This is an even more costly substitution requirement. Crew productivity diminishes, delivery of flowable fill is unpredictable, especially during peak construction months. From an engineering point of view, flowable fill hydrates to a level of stiffness much greater than that of soil surrounding an excavation. Sub-grade uniformity is lost, stress concentrations develop in overlying pavement at the periphery of the excavation. Further, flowable fill suffering a higher than prescribed ratio of cement may require demolition tools for re-excavation purposes. The SCS eliminates the rationale supporting use of flowable fill.



- Viewing the SCS simply as a QC instrument points to further savings. Testing cost is low on a per excavation basis. The SCS does not interrupt the backfill process. The SCS's seismic approach is not tied to time consuming laboratory soil analysis and instrument calibration. Very importantly, SCS results are not skewed by proximity of buried utilities and trench walls – the usual operating environment in small excavations.

- Because the SCS triggers termination of the compaction effort, SCS testing is completed before end result testing can even begin. Because the SCS controls the compaction process and brings each lift to maximum achievable stiffness and corresponding density, rework is virtually eliminated. Conversely, end result testing does not control the pre-test compaction process, is comparatively slow, does not detect protocol violation and often results in rework and/or pavement failure.

- Perhaps the greatest area of cost reduction stems from lower pavement repair costs. While these costs are truly significant, cost savings should be seen as a bonus. Failed pavement is a symptom. The SCS addresses cause – poor reinstatement practice.

THIRD PARTY TESTING:

Extensive independent testing has been performed. In one test, SCS results were compared to over 1100 nuclear densitometer and sand cone measurements. Standard Proctor Density correlations exceeded expectation (95%) on all granular soils. Confidence levels were in the 99% range. Standard Proctor Density correlations on cohesive soils were also good, but it must be noted that acceptable moisture content was critical to achieving desired results on clays and silts. Tests results are available upon request.

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SUPERVISOR

PROTOCOL:

The SCS is used in conjunction with the following protocol:

- lifts not to exceed 12 inches
- hand test for adequate moisture in granular soils. Use a hydrometer to determine if soil moisture is conducive to effective compaction of cohesive materials
- the compaction effort must be continued until the pass in which the SCS gave the stop signal is completed

Final Interesting Point: A nuclear densitometer measurement of 95% Standard Proctor Density, on the top 10 inches of an overly deep 18 to 24 inch lift, could be considered a probability of reinstatement failure as much as a "passing QC test". Applying SCS technology in similar circumstances, crews are forced (green lights) to continue their compaction effort until the best possible result is achieved for the full depth of the lift. While we cannot guarantee that overly deep lifts will be compacted adequately, the probabilities of achieving acceptable results are significantly improved, especially in connection with granular materials. The SCS not only documents protocol violation but initiates real time adjustments in compaction activity to achieve the best possible result in the event of protocol violation.

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