Deep Soil Mixed Walls


Figure 2: CSM Rig

A NEW METHOD of ground modification, cutter soil mixing (CSM), is being evaluated by NZTA for foundation enhancement of the SH16 Causeway Trial Embankment in Auckland. In the USA, CSM has been utilized for another application: support of deep excavations such as shafts, providing a more economical alternative to secant pile and diaphragm slurry walls.

CSM was first introduced in Europe by BAUER Maschinen GmbH and has seen use in Europe, Asia, and Canada. It was used in the USA on the Alternative Intake Project in northern California to construct 20- and 32-metre-deep watertight shafts in alluvial sands, silts, and clays.

CSM is an in situ soil-cement mixing process with the advantage of real-time monitoring of vertical alignment, which is not found with other soil-cement mixing processes. Pile or wall panel drift is a common problem with traditional soil-cement mixing for shaft depths exceeding about 20 metres. Utilizing an inclinometer mounted in the cutterhead assembly, CSM can achieve panel deviations of less than 0.5% of the panel depth, for depths exceeding 30 metres.

With CSM, rectangular panels are created by shearing the soil with mounted cutter wheels, which are attached to a stiff Kelly bar. During the shearing cycle, water is added in predetermined amounts to fluidize the material in place if it is predominantly cohesive, or bentonite is added with the water if the material is predominantly cohesionless. The addition of bentonite keeps the granular material in suspension, which facilitates mixing and keeps the granular material from collapsing. The cutter wheels typically rotate upwards towards each other, directing the soil cuttings towards shear blades that provide additional breakdown of the cuttings. The inclinometer provides the operator with real-time data for the x- and y-location of the cutterhead as it excavates. The operator can change the wheel rotation or 'crowd' the Kelly bar to assist in counteracting deviations of the head.

After the soil is fluidized to the prescribed panel depth, cutterhead retraction begins. During retraction, a predetermined volume of cement grout per cubic metre of panel is mixed with the fluidized soil to form a soil cement mixture. To construct a shaft, panels are interlocked to form a contiguous ring of panels, similar to the way secant pile walls are interlocked. Primary alternating panels are typically constructed first and allowed to cure. Secondary overlapping panels are then cut into and between the primary panels to form continuously interlocking panels. Before curing, the panels can be reinforced with beams if necessary. After the shaft panels are cured, excavation of the soil within the shaft interior commences. Excavation can proceed under wet conditions or

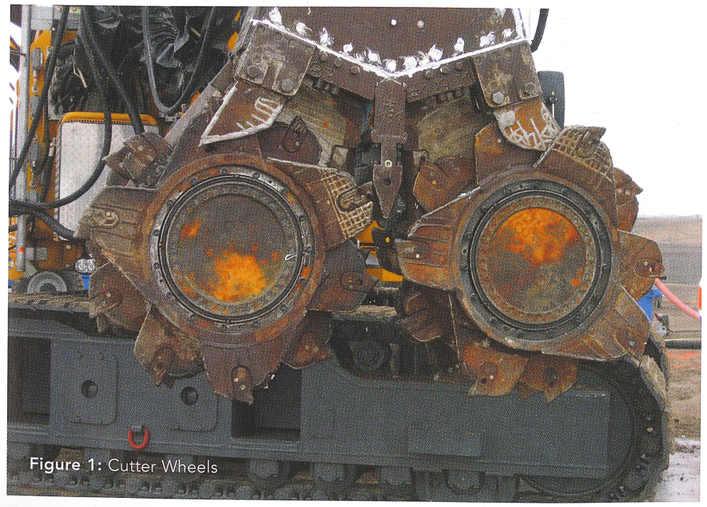
Figure 1: Cutter Wheels


Figure 3: Panel Shearing/Excavation

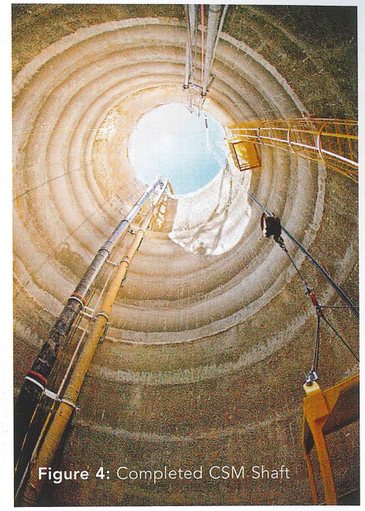
Figure 4: Completed CSM Shaft

dry conditions if a dewatering well is used inside the shaft.

The CSM method can be considered a hybrid of the soil-cement and slurry wall methods. It takes advantage of the economies inherent with in situ soil mixing and the robust support and watertight benefits of diaphragm slurry walls. The accuracy of individual panel installation at significant depths is a distinct advantage of CSM: it provides a high level of confidence that panels are sufficiently interlocked to provide continuous straight or circular walls.

Victor Romero and Norm Joyal
Jacobs Associates

Driven Timber Pile Wall

A TEMPORARY RETAINING wall for a 5.5m deep cut was constructed using this technique. The 5m cut had 20° slope surcharge. I developed this design along with the esteemed Grant Loney (T&T), with input from Andrew Langbein (T&T) – also very esteemed. Though they were sweating about my optimisation in this design.

We used non treated 350SED poles @ 1m centers, predrilled and driven to full depth prior to excavation on a 10% raking angle. Prior to driving the poles we installed and tested pull back anchors, which were later joined and inserted directly into the tops of the poles. After excavation we attached (with nail plates), a geotextile down the face of the poles to stop spalling and weathering. This temporary wall worked perfectly for 6 months. The poles are not recoverable.

Terry Donnelly
Contract Landscapes Ltd

KEY POINTS:
1 CHEAP
2 QUICK
3 EFFECTIVE