HazMat Central '90
March 13, 14 and 15, 1990
Rosemont, Illinois

INSTALLATION OF VERTICAL BARRIERS USING DEEP SOIL MIXING

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INTRODUCTION

As contamination from liquid wastes and polluted groundwater continue to be a major environmental remediation topic, methods and applications for installing vertical barriers continue to evolve. The need to contain the pollutants to reduce their potential effects has broadened the scope of a vertical barrier. Greater depths than before are required as the contamination continues to migrate downward. The locations selected for a barrier wall vary from placing them around a preplanned disposal site, to installing them next to existing structures.

This variety of applications necessitates the advancement of technologies to install them. A technique currently being used is the Deep Soil Mixing (DSM) method. DSM is capable of reaching depths of 120 feet or more, and installing a barrier with in a few feet of existing structures. Inherent in the system are added benefits of no open excavations and no removal of contaminated soils.

DSM TECHNOLOGY

DSM is a relatively simple process involving standard construction equipment rearranged for the process. The equipment mixed the slurry and soil to a defined dimension.

The equipment is a crane-supported set of leads which guide a series of four hydraulically driven mixing paddles and augers. As penetration occurs, a slurry is injected into the soil through the tip of the hollow stemmed augers. The auger flights penetrate and break loose the soil and lift it to the mixing paddles which blend the slurry and soil.

As the auger continues to advance, the soil and slurry are remixed by additional paddles attached to the shaft. All of the slurry is injected as the augers penetrate downward and as they are withdrawn, the mixing process is continued on the way out. A continuous wall can be formed by using an overlapping primary and secondary stroke sequence (Figure 1).

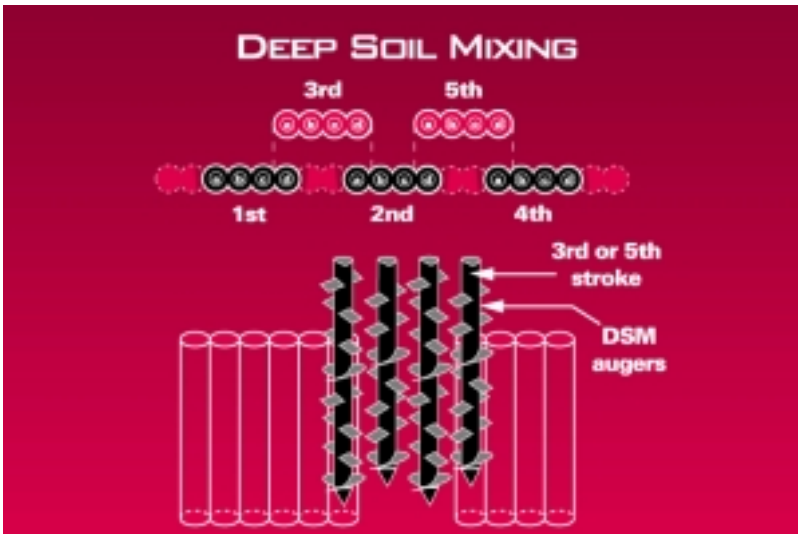

Figure 1

When used as a method to install a cut-off wall around a hazardous site, DSM also offers advantages over conventional methods. The soil does not have to be excavated to install the wall, and if the soil is contaminated, large disposal costs are saved. Work and staging areas are smaller than needed for other methods because there is no aboveground mixing area or bentonite pond. The wall is constructed in small sections, so there is no danger of collapse in soft soils

When installing a cut-off wall, a relatively small amount of soil is treated compared to the mass of soil the wall surrounds.

DSM VERTICAL BARRIER APPLICATION

PCB contaminated soils were discovered on the site of a large manufacturing firm. Concentrations were found within two large areas. In order to isolate these areas and prevent leaching into a nearby river, the owner chose to have a vertical barrier installed (Figure 2).

However, the installation required placement of the barrier within four feet of the river's edge. This area contained very soft conditions. The soil conditions coupled with hydraulic forces from the river raised concerns that conventional methods, such as slurry trenching, might fail during construction.

In addition, the barrier would be installed through contaminated soils and any soil excavated would have to be disposed of at acceptable landfill sites. These sites were several hundred miles away and would significantly raise the cost of the project. These soils extended to depths of sixty-eight feet. Below the soft soils was a dense clay till which could act as an ideal aquiclude.

Due to the stability, depth, and disposal concerns, DSM became the overwhelming choice. DSM does not require excavation for installation of the barrier. In-situ soils are blended in with the slurry alleviating the stability and disposal concerns. DSM can reach much greater depths more economically than conventional methods.

The four-auger machine allowed for twenty-five cubic feet of wall to be installed per vertical foot drilled. A continuous mix slurry plant supplied the volume required for the four-shaft machine.

Technical requirements for the cut-off wall specified a permeability of 5×10^{-7} cm/sec. To meet this requirement, over fifteen soil mix designs were evaluated. The soil mixes were tested for compatibility with the leachate, permeability, and strength before selecting a cement-bentonite slurry.

Over 250,000 square feet of vertical barrier were installed. The cut-off wall was keyed two feet into the dense till layer which, in some areas, was almost seventy feet below the existing ground surface. The client requested that approximately 2,600 linear feet of the cut-off wall be structurally fortified by the addition of structural steel beams to allow for future excavation of contaminated soils inside (away from the river) the wall area. Geo-con added the steel beams and provided the client with a cantilever retaining wall capable of supporting the load applied.

OTHER APPLICATIONS

Treating the soil in place saved the owner the expense of removal and disposal of the contaminated soil and eliminated a sensitive and complicated operation. There was less exposure of the workers to potential health hazards than a trench would have offered.

Because of the ability to treat soils in place, other potential applications for waste containment and hazardous waste site remediation could involve introducing other agents to destroy wastes or chemically treat them.

The most obvious application is in-situ stabilization of contaminated soils and sludges, but there are other potential uses that are also economical. For aerobic

Bacterial destruction of organic wastes, oxygen can be pumped through the augers and out the tip at high enough pressures to aerate the soil and accelerate its bacterial activity. (Existing applications of aerobic destruction are limited to near-surface spills.)

Steam or other heated gases can be injected through the augers to strip the soil of volatile organics. A hood at the surface would evacuate the waste gases to a plant for recovery and disposal. This method would decrease the potential for offsite emission that is always present during an “excavate and remove” type of operation.

More applications will be devised as DSM becomes more widely used in the United States. The method is becoming an established specialty technique.

CONCLUSIONS

Vertical barriers continue to be an essential part of most waste containment plans. While conventional slurry wall techniques will continue to have the most use, DSM is emerging as a viable alternative. DSM can be placed in areas with stability problems. It reduces risk of exposure to the workers and the environment, excavation and disposal costs are virtually eliminated, and greater depths can be reached more economically than other conventional methods.