

## Soil Stabilization By Jet Grouting

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Jet grouting is an *in situ*, erosion-based technology that uses high velocity liquid jetting to simultaneously erode and replace the soil with cement grout, creating a final product known as Soilcrete. The technique was originally developed in Japan and has gained steady acceptance in North America over the past ten years. Since 1986, more than 200 jet grouting projects have been successfully completed.

Applications of this system fall into three broad categories: underpinning and/or excavation support, temporary or permanent stabilization of soft soils, and groundwater or pollution control. Jet grouting is an alternative to traditional grouting systems, deep slurry trenching, underpinning systems, micropiling, freezing or the use of compressed air in tunneling.

A versatile and flexible technology, jet grouting is effective across the widest range of soil types of any grouting

system, including silts and some clays. Jet grouting can be accomplished in confined spaces and around subsurface obstructions such as utilities. Since all work is performed above foundation grade, jet grouting is also a very safe operation.

### Jet Grouting Systems

Jet grouting is typically accomplished by either the single-, double- or triple-fluid system, as shown in figure 1. The most appropriate system for the job is selected based on the *in situ* soil, the application and the physical characteristics of the Soilcrete required for the application. In reality, any of the systems can be used for almost any application provided that the correct design and operating procedures are used.

### Jet Grouting Procedure

The basic jet grouting procedure is illustrated in figure 2. The technique allows for a variety of geometries to be constructed, from full columns to partial columns to panels. Elements are always constructed in a designed sequence to allow the Soilcrete to set up and to ensure that structural

integrity is maintained.

### Quality Assurance and Quality Control

The QA/QC program is critical to successful jet grouting. Pre-production quality assurance measures include:

- A test section to verify the design geometry of the Soilcrete and the quality and strength characteristics of the Soilcrete product.
- Laboratory testing of retrieved samples for unconfined compressive strength.

In addition to specific quality control inspection items during production, structural monitoring or permeability testing may be required, depending on the project.

### Case Studies

The following case studies illustrate only three of the broad range of construction problems that can be solved by jet grouting.

**General Hospital Center at Passaic, New Jersey.** Concerned that a conventional pit underpinning method would result in excessive settlement of the existing, five-story hospital structure, the general contractor elected to use a jet grouting alternative for construction of a new, three-story addition. The site for the addition was pre-excavated to the top of the five-story structure's foundations. Existing column footings and foundation walls were then underpinned to a competent bearing stratum by 3.5 foot diameter, interconnected Soilcrete columns. The continuous wall thus formed also provided

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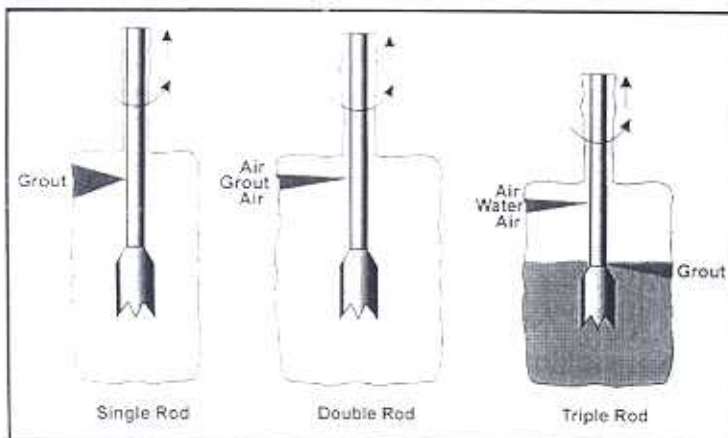


Fig. 1: Jet Grouting System

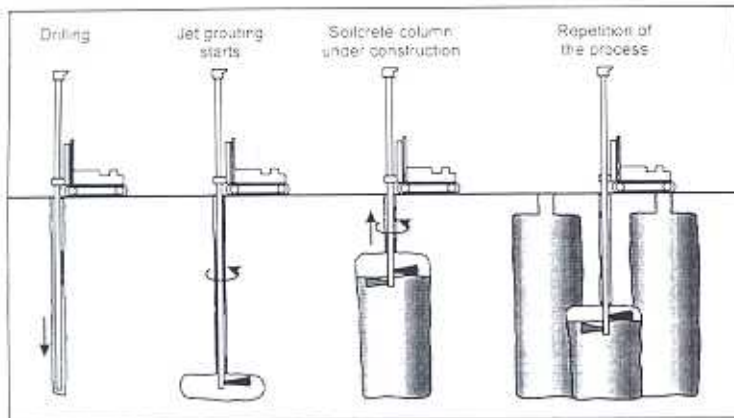


Fig. 2: Jet Grouting Procedure.

support for subsequent, deep excavation of the prevailing clean sands. Existing building settlements were negligible.

**Molly Ann's Brook, Paterson, NJ.** A Corps of Engineers flood protection project involved widening the existing channel and temporarily lowering the stream bed approximately six feet to allow construction of concrete retaining walls directly adjacent to four structures.

The depth of the excavation and its proximity to these adjacent structures necessitated underpinning the foundations. The high groundwater conditions made conventional underpinning by means of hand dug, sheeted pits dangerous and costly.

The contractor performed the underpinning operation by utilizing jet grouting methods. A total of 300 lineal feet of underpinning was provided at these four structures to create a trapezoidal mass of Soilcrete beneath the existing structures that functioned as both underpinning and lateral earth support.

The neat cement grout used in the operation was mixed on site

and pumped approximately 300 feet to the point of injection. Approximately 600 tons of Type 1 cement were used on the project.

Samples of the wet Soilcrete were retrieved for compressive strength testing to confirm that the design strength of 300 psi was achieved. The 28 day strengths of the *in situ* samples ranged from 700 to 2,000 psi. Long-term monitoring has shown negligible settlement of the underpinned walls.

### Battery Park City, New York, NY.

Battery Park City, created on material excavated during the construction of the World Trade Center, includes a 70-foot wide river-front esplanade consisting of a reinforced concrete relieving platform that supports several feet of soil. Running parallel to the river, the esplanade supports vertical timber sheeting to retain up to six feet of soil.

Recent improvements in water quality resulted in an increase in marine borers which attack and destroy the timber sheeting. If left unattended, the result would be loss of soil and surface subsidence.

Because of extensive development of the area, conventional construction methods for replacing the timber could not be used. As a result, the contractor placed an *in situ* structural wall directly behind and in contact with the timber sheeting. Through jet grouting techniques, a Soilcrete



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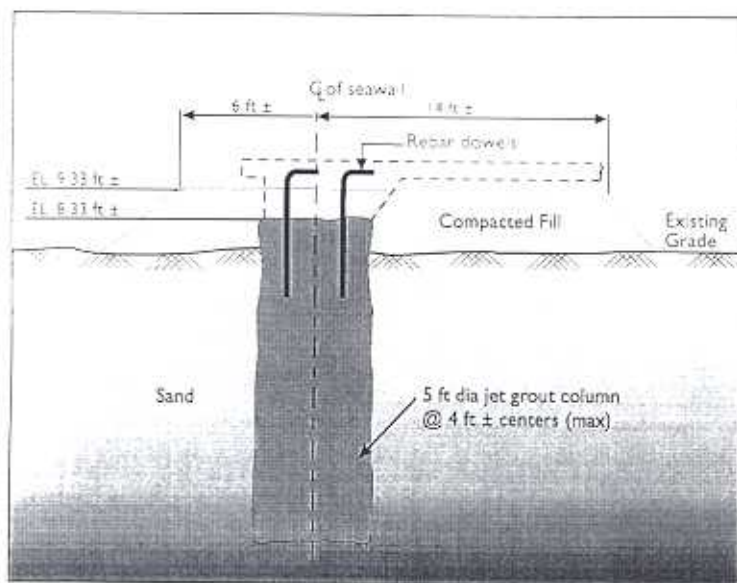


Fig. 3: Jet Grouted Seawall

wall thicker than three feet was created along an 800 foot stretch of esplanade to a depth of approximately 20 feet.

Subsequent quality assurance

testing confirmed that the specified 3,000 psi compressive strength of the Soilcrete wall was attained. Over 15,000 tons of cement were used for the project.

**Summary**

Jet grouting offers a unique degree of design flexibility for a broad range of applications. Usually, the jet grouting work can be accomplished without disrupting normal facility operations. Jet grouting is not only one of the safest methods of construction available, but in many cases the process is so fast that the result is a saving in construction schedule time. ■

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