



## VERTICAL AND INCLINED JET-GROUTED COLUMNS FOR FOUNDATION ENHANCEMENT OF CENTRAL HIGH SCHOOL

**Location:** Central High School at Lowell Street in Manchester, NH

**Age of existing building:** Constructed in mid 1950s

**Specs of new foundation:** 12 ft (3.7 m) below from the bottom of the footings of the existing building. Excavation along the existing foundations would run approximately 300 lineal ft (92 m) in plan.

**Subsurface conditions:** Loose to medium dense, Fine to medium sands with groundwater at about 3 ft (0.9 m) above the proposed foundation subgrade.

This job consisted of the construction of a one-level, below-grade parking garage between and immediately adjacent to two existing structures.

Subsurface conditions through the zone of excavation and at the subgrade level of the proposed structure made the conventionally used underpinning piers risky for excavation support, and thus maintaining the integrity of the existing adjacent buildings during construction. For this project, GSI developed lateral rigidity of the excavation support system by designing an arrangement of composite jet-grout columns, where each support unit consisted of one vertical and one inclined column integrated structurally at the top. The design created a contiguous soilcrete mass providing underpinning as well as lateral restraint during the excavation for the proposed underground garage.

During the implementation of the production columns the drill string was first advanced to the bottom elevation of the column, and subsequently retracted at a rate of 12 to 18-inch (300 mm to 450 mm) per minute with rotation of 12 to 18 revolutions per minute. Water pressure maintained at approximately 400 bar, water injection at a rate between 80 and 90 liters per minute, the grout injection at a rate of around 140 liters per minute, and the air pressure at 7 to 8 bar.

Upon extraction of the drill string, jet grout columns were maintained flush with the operating platform (ground surface) by continuous addition of grout to offset shrinkage due to hydration. Sequencing of the jet grout columns was arranged to have a minimum distance of 14 ft (4.3 m) between the successive columns installed on the same day. Vertical and inclined columns as a pair were installed as a pair on the same day such that a "wet on wet" construction was implemented for effective integration of the soilcrete mass.

