UTILIZATION OF A MICROPILE SECANT WALL IN HISTORIC CHARLESTON, SOUTH CAROLINA

William L Snow, Sr.[1] and William L Snow, Jr. P.E.[2]

As many people know, Charleston, SC is a growing city and is considered by many to be one of the best places to visit in the US. The travel magazine, Conde' Nast has rated Charleston the number one destination in the USA for five years and in the top 3 worldwide for four of the last five years. This designation and many other publications have transformed Charleston from a somewhat slow paced Southern town into a busy city with all of the associated benefits, as well as problems which come with an over stressed infrastructure.

This paper deals with a situation which is all too common in this metropolitan environment, and other areas with similar growth and prosperity. People come to Charleston to experience the charm and culture of a historic Southern city. That culture and history is most apparent in the fixed geographical area of downtown Charleston, specifically in what locals call the Charleston peninsula. All of those visitors, whether they come by plane, car or one of the many cruise ships which call on the Holy City, need a place to sleep and to park their cars. When there is a need, entrepreneurs will fill it. The focus of this presentation is on the explosion of tourism in the city and one part of the infrastructure required to facilitate those tourists.

Hotels are relatively easy to build. The developer finds a property they are willing to spend large amounts of money for and then build a building with as many rooms as possible so they can recoup their expenses renting rooms. The problem arises as to where to park the cars that bring these tourists to Charleston. The problem is so acute that the City government has set a requirement that in order to get a permit to build any structure; the application must include a designed parking structure on the site. On street and overnight parking is simply not possible anymore, nor is it allowed under city ordinances.

There have been two structures to date which have included underground, on-site parking. One was accomplished using an extraordinary structure made possible utilizing permanent driven and vibrated sheet piles, driven deep foundation piles and an extensive, permanent dewatering system. Although the site is rather large by local standards, the driven and vibrated sheet piles caused extensive damage, which is still being litigated, to structures immediately across the street. The effect of the permanent dewatering is still being investigated, and possibly litigated.

The second project to utilize underground parking is the project we will present today. The site of this proposed hotel is very small and confined. The limits of the actual structure are basically the property lines which are bordered on three sides by city streets and on the fourth side by an existing one story, unreinforced masonry structure which is

[1] President, Palmetto Gunite Construction Co., Inc., P.O. Box 388, 5330 Savannah Highway, Ravenel, SC 29470-0388, +1 (843) 889-2227, snowwl@aol.com

[2] Vice President of Engineering, Palmetto Gunite Construction Co., Inc., P.O. Box 388, 5330 Savannah Highway, Ravenel, SC 29470-0388, +1 (843) 889-2227, williamleesnowjr@gmail.com

well over one hundred years old. The structures immediately across the two side streets are three story, unreinforced masonry structures that predate the 1886 earthquake and are considered designated historic structures. They currently are occupied by high end offices, warehouses and some of the most high end restaurants in the city. Any plan to build below grade had to take the protection of these buildings into account. Any resultant damage to these structures would have brought the proposed construction to an immediate halt, resulting in substantial economic losses for the developer. No one has ever attempted such a structure in the somewhat unique soils of Charleston.

Our company was contacted originally to provide a method to support and/or underpin the one story building adjacent to the proposed hotel. During discussions with the developer, the architect and especially the geotechnical engineer, it became immediately evident that there had been no thought given to the problems of digging a 14 foot deep hole in the ground to the absolute limits of the property footprint. Remembering that those limits on three sides were city streets, the issue became acute when a review of the soil boring showed a consistent 10 foot sand layer beginning 3 to 4 feet below the existing grade. This condition caused the water table at the site to be completely tidally influenced given that the Charleston harbor is less than 200 feet from the site. Open excavation was completely out of the question which made a shoring system that would fit the site a primary requirement for the project to move forward.

The developer requested us to provide them with a viable solution to the unique problems faced on this site. The requirements were to construct a support system for the entire structure that could not include any system that caused any vibrations to adjacent structures. The system had to provide support for the required excavation, it had to be constructed within the property and right of way lines and it had to be inches thick, not feet. Dewatering the entire site was considered too much of a risk to adjacent structures given the high probability of resultant subsidence of the existing sand layers located within the normal water table. The following engineering design and construction methods are outlined below.

Our company's solution was to install an interlocking micropile secant wall around the perimeter of the excavation. In talking with the architect and the mechanical parking system supplier, the tolerance for the secant wall turned to practically zero in two directions. Our micropile drill rigs could install the piles within one foot of the existing building. The new construction which will have a drive isle through the site had to be offset from the main road by seventy feet, which gave our secant wall a tolerance of 1 inch. Another challenge was the structural piles for the building had to be incorporated into the secant wall due to the tight site restrictions. The secant wall micro piles had to be installed to a depth of thirty feet below the existing grade to fully penetrate the roughly 6-foot-thick clay layer in order to seal off the groundwater from the excavation. The structural piles were designed for 50 tons and were installed to a depth of 80 feet below the existing grade. All of the piles were tied together with a structural beam across the top of the secant wall. In total, there were 242 secant micropiles and 32 structural micropiles that were incorporated in the secant wall.

The geotechnical engineering report stated that there was historical debris on the site that had to be considered during construction. The extent of this debris was not known at the time of design. Typically, historical debris can range from a few bricks and glass in the upper one to three feet or it can consist of up to 8 to 10 feet of debris. This

site was located just outside the original 1700 wall of Charleston. Once we started drilling on the site, we quickly realized that the historical debris consisted of closer to 8 to 10 feet of bricks, glass, and large ballast stones. There were also several brick foundations that were discovered during drilling several feet below the grade. Drilling through this debris while maintaining the tolerances for the project proved difficult. In order to drill through the existing brick foundations, each pile location had to be cored. These shallow foundations could not be excavated prior to the installation of the secant wall micropiles because they were adjacent to a city street which could have been undermined if they were removed.

The secant wall was designed as a temporary shoring system for the excavation. A concrete beam was constructed across the top of the wall tying the micropiles together. There were also two temporary braces that were installed across the top of the excavation on the beam. The temporary bracing was necessary due to the high hydrostatic pressures from the shallow groundwater until the final structure was constructed in the excavated pit. Dewatering the site outside of the excavation and secant wall was not possible and could have potentially caused settlement of the shallow foundation historical buildings adjacent to the site. Once the excavation was completed to a depth of approximately 12 feet, approximately 18 inches of rock was installed over a biaxial geogrid to provide a stabilized working platform. A 12-inch-thick slab was installed that was tied into three 70-foot-long micropiles in the middle of the excavation that were required to resist the long-term hydrostatic uplift on the structure. An 8-inch-thick shotcrete wall with a waterproofing additive was then installed against the secant wall to provide the permanent structural shoring. The remainder of the building was supported by 4, 80-foot deep cased micropiles.

The use of Secant walls is not a new concept. The integration of micro piles in the construction of the secant wall, coupled with structural micro piles which provided the primary deep foundation support of the entire structure has never been attempted before in the unique soil profiles of the Charleston peninsula area. The finished structure exceeded our most optimistic design parameters. Once the excavation was completed, there was some pore water pressure release requiring pumping of the limited excess water. This was accomplished using a small 2 inch electric pump for a few days. After pumping small amounts of water over one weekend, the excavation was relatively dry. After the shotcrete wall was installed, there was very little, if any leakage in the newly finished pit.

The finished hotel structure will house approximately 34 rooms and provide underground parking to accommodate up to 30 vehicles to be stored in a stackable machine.