

BUILDING ON THE FOUNDATION OF TOMORROW SINCE 1986



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One of the Largest Mat Foundations in
Michigan: Library Lane Underground Parking
Structure -- Ann Arbor, Michigan



Groundwater flow, high surcharge loads from adjacent structures, and weak soil conditions were challenges met by Haengel & Associates

Engineering (HAE) in this landmark Ann Arbor project. The Library Lane Parking Structure has 700+ vehicle capacity in four underground levels. The parking structure also provides support for future buildings of four and 25 stories each that are included in the project master plan. Haengel & Associates' multiple geotechnical engineering specialties and construction materials testing services provided solutions for groundwater pumping, temporary secant retaining walls, and the construction of a massive concrete mat foundation, one of the largest ever constructed in Michigan.

Hydrogeologic investigation and study presented the dual challenges of groundwater pumping with limited storm sewer capacity and the presence of nearby dioxin plumes from disposal decades earlier. Pumping volume for dewatering to base elevation would be very high, which Haengel & Associates estimated at 1.6 million gallons per day steady state pumping for a 100-day period. The pumping rate was several times higher during the initial unsteady state pumping conditions. Haengel & Associates devised a solution for efficient pumping of the groundwater, utilizing up to 50% of storm sewer capacity, but without drawing dioxin plumes into the flow. This required establishing a negative-pressure groundwater condition, continuous monitoring, and a water cleaning system.



Haengel & Associates also provided soil parameters and design

considerations for the temporary earth retention secant walls and for the permanent below-grade walls of the parking garage. Both wall systems go to 45 feet below grade. Haengel & Associates anticipated that the below-grade walls would be fixed at the top and relatively rigid. For these conditions, an equivalent fluid at-rest earth pressure of 60 pounds per cubic foot (pcf) per foot of wall depth was recommended. This lateral pressure assumed the use of a free-draining granular backfill and at-rest conditions behind the below-grade walls. Further, it was anticipated that the temporary wall, over time, could develop active earth pressure. For active pressure to develop, the outward movement of the top of the temporary wall would be on the order of 0.001 times the wall height. Additionally, calculations were made of surcharge loads on the walls created by existing adjacent large buildings and streets.



Most notably, this project has one of the largest mat foundations ever constructed in Michigan. Haengel & Associates evaluated several foundation candidates and construction methods, ultimately recommending the mat foundation for its optimal combination of cost effectiveness and acceptable total and differential settlement. Site geology and hydrogeology, with bedrock some 250 feet below ground surface and groundwater encountered near 50 feet below ground surface, challenged more common foundation approaches and presented a need to counteract buoyancy effects of groundwater. The mat foundation has thickness up to 15 feet and was constructed with high-strength 10,000 psi concrete. However, the construction process for this foundation system would be an ambitious endeavor, requiring a continuous, highly controlled concrete pouring process, with concrete deliveries numbered in the thousands of truckloads. Single sections of

the mat foundation required pours of more than 6,000 cubic yards of concrete. Haengel & Associates served as the Engineer of Record for the testing and monitoring of the concrete pour, with 30 engineers onsite providing 24-hour services during the two-day pouring of each mat section. Concrete integrity was assured by careful control of internal stresses and core temperatures, precise timing of pour placement, and rigorous delivery sampling.

High-Capacity Steel Foundations for Buildings, Industrial Structures, and Retaining Walls

Wherever you would use deep foundations, piles, pile alternatives, or large concrete pours, consider Structural Foundations. With Haengel & Associates, Structural Foundations engineers and hydraulically installs high-capacity steel foundations saving up to 50% in cost and valuable time.

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