

# BUILDING ON THE FOUNDATION OF TOMORROW SINCE 1986



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## Project Showstoppers: How Geotechnical Engineering Can Prevent Them



It's all too common in the construction industry to hear about a project being delayed or stopped due to unanticipated soil conditions, groundwater, or contaminants encountered during site preparation and foundation installation. At a minimum, these can cause a substantial cost increase and significant disruption of project schedule. We

discussed some common and unusual “project showstoppers” with Haengel & Associates Engineering, Inc. (HAE). This discussion will help owners, developers, architects, and engineers to give deserved importance to pre-design geotechnical and environmental investigation. The small expense of this pre-design investigation at the start of a project can save a lot of grief and expense during and after the project.

Q: What’s the most common ‘showstopper’ that you’ve encountered in your long professional careers?

*A: Assumed Soil Conditions*

Too often, we get called when a structure has already been designed, construction has started, and the excavation contractor notices that the soils appear to be too soft and too loose, or that the water level in the foundation pit is higher than the footing base. We then test the footing base and discover that the available bearing capacity is much lower than the design bearing pressure. For example, a spread footing designed to bear 2,500 pounds per square foot (psf) will be located in a soil condition that can bear only, say, 1,500 psf. A geotechnical investigation report would have addressed any of these adverse conditions, helping the design engineer to budget more realistically and avoid these costly surprises.

Q: Any foundation redesign that follows must then be a ‘showstopper’ in itself?

*A: Common Foundation Alternatives Can Be Too Costly*

In the previous example, the project engineering team will need to consider foundation alternatives. The first alternative, increasing footing sizes, may reduce the bearing pressure, but may increase potential differential settlement. A second alternative, using common deep foundation systems, may significantly increase foundation cost. We’ve seen project budgets sunk by foundation redesigns that are excessively costly, angering owners. In so many scenarios, there are alternative systems that can provide the desired performance with more favorable economics. This is where we, as experienced geotechnical engineers, can make a big difference in projects.

Q: What is foundation cost relative to total project cost and how can you lower it?

*A: Consider Multiple Foundation Options and*



Foundation cost is often 20% to 35% of building construction cost. My colleagues and I are proficient in the use of all varieties of foundation types to most economically serve the particular circumstances. Some of these are traditional shallow footings, which include continuous footings, spread footings, and large mat foundations, and common deep foundations, which include wood/timber piles, helical piers, aggregate piers, steel H-piles and pipe piles, and auger-cast caissons. More recently, we have adopted steel foundations by Structural Foundations, which, in many cases, can further reduce foundation cost and installation time significantly. Each of these foundation types has its performance and cost merits for a particular situation. At Haengel & Associates, we cover structural and other engineering disciplines, and even obtain estimates from reputable suppliers and contractors who provide these innovative solutions, giving our clients a cost comparison.



Q: What's one of the more challenging site conditions that you've encountered?

*A: Foundations Submerged in High Groundwater*

Few things are more disruptive to foundation construction than the surprise of finding high groundwater during construction. We once arrived at a project site to do an engineering evaluation of structural piers, only to find that the piers were submerged in water! There was no geotechnical investigation and the groundwater level had been assumed to be lower. In addition, compounding the problem, the piers were undersized for the existing soil conditions. With a geotechnical

investigation, we could have determined current groundwater levels with piezometers and established seasonal fluctuations. A geotechnical report would have predicted the situation and recommended proper design parameters for the piers and a dewatering system to be available during construction, all without stopping the project.

Q: What's one of the more unusual 'project showstoppers' that you encountered?

A: Groundwater Pumping with Discovered Contaminants

We have projects where a continuous groundwater pumping system is necessary, both during construction and over the life of the structure. A less common 'project showstopper' is the presence of contaminants in groundwater that's being pumped. This creates a great challenge with environmental authorities, especially when pumping rates can be in the range of tens of thousands of gallons per hour. However, with hydrogeologic investigation, we can identify, for example, locations of chemical plumes and understand their behavior and flow. We can then calculate appropriate flow rates so as not to induce chemical flow into the groundwater being pumped. We've succeeded to safely pump groundwater in this scenario by creating negative pressure conditions and providing continuous monitoring capability. Again, this need not be a budget-busting proposition or necessarily a reason not to build on a particular site.

Q: What words of wisdom will you share with us?

A: *Know Your Soil and Groundwater Conditions!*

A fundamental of engineering is that what your foundation system will bear is a factor of what your soil or rock will bear. In our profession, we try to spread the word that geotechnical investigation often isn't an expensive component of the project budget, and that it can avert very costly problems once construction has begun. In fact, a sizable portion of our work is on projects where problems have been encountered, even emergencies, because soil and groundwater conditions were incorrectly assumed. Much can be saved in time, cost, and headaches by investigating the site conditions up front and then carefully evaluating various foundation systems and soil improvement methods. A stitch in time (*few thousand dollars for a geotechnical report*) saves nine (*many thousands of dollars in project budget overrun, delay, and cost of arbitration or litigation.*)







## HAENGEL & ASSOCIATES ENGINEERING

*Geotechnical, Structural, Construction, & Inspections.*

### ***Participants from Haengel & Associates Engineering, Inc.***

*Gus Haengel, M.S. is the Principal Engineer of HAE, with long and diverse experience in the construction industry, working with consulting firms, city engineering departments, and leading his own engineering firm. He is known affectionately as “Mr. 911,” the emergency problem solver of the construction industry in Michigan.*

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