

# A Fundamental Shift

Expanded Foundation Alternatives via the Domesilo™



Deep foundations, such as the one being constructed with steel pilings here, were an unavoidable expense and source of lengthened construction schedules for traditional structures.

## The Bulk-Storage Dilemma

The need for storing bulk quantities of material and the soil conditions for doing so are frequently at odds. Land at ports, for example, can be very expensive and require material to be stacked tall on a small area of ground. The ground being stacked on, near water, is usually soft and unable to naturally bear these loads. Often bulk storage is constructed upon cleared land with soil that has been unevenly compacted or placed. In these and many other scenarios engineers have to account for the likelihood of settlement or proposed expensive deep foundations.

When settlement occurs uniformly across the footprint of a storage structure the consequences are more manageable. But, when settlement occurs unevenly a structure and its appurtenances (connecting trusses, piping, wiring, etc.) can sustain damage or fail completely. This more harmful type of settlement is called differential settlement. Certain types of structures, by their shape and construction, are more likely to fail from modest amounts of differential settlement.

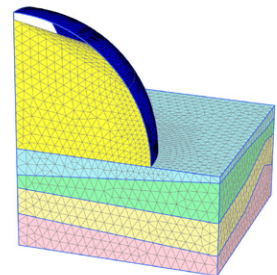
The solution in the past for eliminating the opportunity for differential settlement on soft or mixed soils has been simply to construct deep foundations. This is done by driving an array of steel or reinforced concrete piles deep enough into the ground to reach solid bedrock or a hard soil layer deep in the earth. If the building is supported upon these piles, which rest on solid bedrock, the foundation of the building is secure. While this is a viable and proven *engineering solution*, it introduces a major *business problem* because constructing a deep foundation is expensive and time intensive.

Because failure of a structure is unacceptable, and traditional structures have difficulty handling differential settlement, there has been no alternative but to absorb these costs, relocate, or abandon a project. That was until recent decades, with the introduction of the Domesilo™.

## Greater Strength, More Stability

The Domesilo filled with bulk material is still heavy, and will still experience settlement like any other storage structure, but it is uniquely equipped to handle this settlement due to its unique construction and shape.

A Domesilo is a monolithic, thin-shell structure of continuous steel-reinforced



Settlement analysis of a Domesilo.



This foundation is constructed by filling augured out soil with rammed rock aggregate, offering an intermediate, more affordable alternative to deep foundations.

concrete utilizing nature's strongest form. Absent are joints and seams that create failure points on traditional structures. Compressive strength of concrete and the tensile strength of reinforcing steel create a shell of incredible strength. Its double curvature shape, especially on shorter hemispherical domes or those with smaller stem walls, will disperse loads more evenly across the entire structure. These combined attributes offer strength never before seen in a traditional silo or warehouse of equal cost. Because of its strength a Domesilo is able to tolerate settlement variance from one side to the other of about 1 to 2 feet.

The Domesilo is also less likely to topple from settlement due to its lower height to width ratio. Whereas a traditional concrete or steel silo will often rise 5 times taller than the width of its base, Domesilos rarely rise greater than 1.2 times taller than the width of their base, making them much less vulnerable to differential settlement.

Because the dome is able to tolerate greater levels of settlement, the question of foundations is no longer just one of whether a deep foundations is required or not, but which of an array of intermediate options can be employed at reduce cost and construction time.

## New Foundation Choices

Among the intermediate foundation solutions now available because of the Domesilo's ability to tolerate greater degrees of settlement are stone columns. In this foundation system the weak, soft soil is augured out and replaced with rammed aggregate to about 30-35 feet in depth. This shallower rock column is less expensive than deep steel pilings and can provide sufficient settlement reduction for a Domesilo.

Another alternative is a geotextile reinforced soil mat. The softer soil is replaced with compacted fill and a geotextile fabric placed in alternating layers of fill and fabric. While this also allows for some settlement, when engineered properly it is within the increased range the dome can handle.

A piled raft system is another alternative. In this foundation, piles are still driven down to harder ground, but the piles are spaced out further than in a traditional deep foundation. The piles and the earth work together to support the structure. Again this system allows for some settlement, but compared to the alternative, at a significant reduction in time and cost.



The lower height to width ration of a Domesilo makes it less likely to topple than taller and narrower silos.



Real estate along waterways can come at a premium, such as at the site of this cement storage Domesilo.

## The Competitive Advantage

Deep foundations are still required in some instances where settlement is calculated to be greater than even the stronger and more stable Domesilo can tolerate. However in many other instances these intermediate solutions are just as capable, more affordable, require less time to build, and allow companies to store greater quantities of product when and where they need it.

This flexibility offered by the Domesilo is a competitive advantage to the many firms currently leveraging it in their production or supply chain. As a pioneer of the steel-reinforced concrete dome and having constructed more industrial storage domes in more places around the world than any other builder, Dome Technology offers competence that only comes with experience—over 35 years of experience. On sites with complex foundation requirements and thanks to the Domesilo, our closely integrated team of engineers and builders can now deliver the right solution, not just the most expensive one.



These 60,000 tonne capacity grain Domesilos are able to withstand more differential settlement than traditional silos of equal capacity, providing more options to the owner of this port terminal in Canada.

Douglas Weber is a principal at Engineering System Solutions (ES<sup>2</sup>). During his career he has engineered dozens of Domesilos, some ranking among the world's largest bulk-storage structures, on nearly every soil condition imaginable.





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