An Introduction to

SHANER INDUSTRIES

Metal Foundation System

By Michael L. Schumaker, P.E.

INTRODUCTION

Various types of deep foundations are routinely used to support structures. Selection of the appropriate type of deep foundation for a particular application is influenced by many factors, including:

- Load capacity and pile spacing
- Performance criteria such as vertical settlement and lateral displacement
- Subsurface conditions
- Availability
- Constructability
- Cost

Selection of the type of deep foundation for a particular application can be influenced by the design or construction teams past experience. However, implementation of an innovative deep foundation system that can reduce construction schedule time and foundation costs can be overlooked if the Owner, Engineer or Construction Manager of a project is not familiar with the alternate foundation type. This paper presents information relative to a deep foundation system that can be used as a time-saving and cost effective alternative to traditional deep foundation systems.

BACKGROUND

Deep foundations can be categorized as displacement piles or replacement piles. Displacement piles typically consist of structural elements that are driven or vibrated into the ground, thereby displacing the surrounding soil laterally, often at the same time improving the soils engineering characteristics during installation. Replacement piles are typically installed by excavation and are typically constructed within a drilled borehole and backfilled with cast-in-place concrete, thus replacing the excavated ground with the pile element.

Displacement piles typically include structural steel or precast concrete elements. Common elements used for displacement piles include structural steel H sections and pipes, and precast concrete. Steel piles are strong, relatively lightweight and easy to handle, can be cut or welded to length in the field, and are relatively easy to fabricate. Precast piles are typically fabricated with concrete in a casting yard and are reinforced with steel. Precast concrete piles are typically relatively heavy and difficult to handle and are very difficult to modify in the field.

Conventional steel and precast concrete piles are installed by driving with impact hammers or by vibratory methods. Driven piles can be vulnerable to damage from using the incorrect hammer, insufficient cushioning, misalignment of hammer and pile, and subsurface obstructions and poor driving conditions. Damage typically consists of head or toe damage, cracking of the shaft, spalling at the head in the case of precast piles, and failure of splices (for long piles).

Replacement piles generally consist of drilled shafts and auger-cast-in-place piles. Drilled shafts are constructed by drilling holes, placing reinforcing steel cages, and filling the shaft with concrete. Auger cast piles are constructed by drilling with an auger to the bearing depth and by injecting grout under pressure as the auger is withdrawn. Installation of replacement piles results in excavation spoils that need to be handled and disposed of. This type of piling has the benefit that it is easy to modify length, and limited ground vibrations are generated during installation.

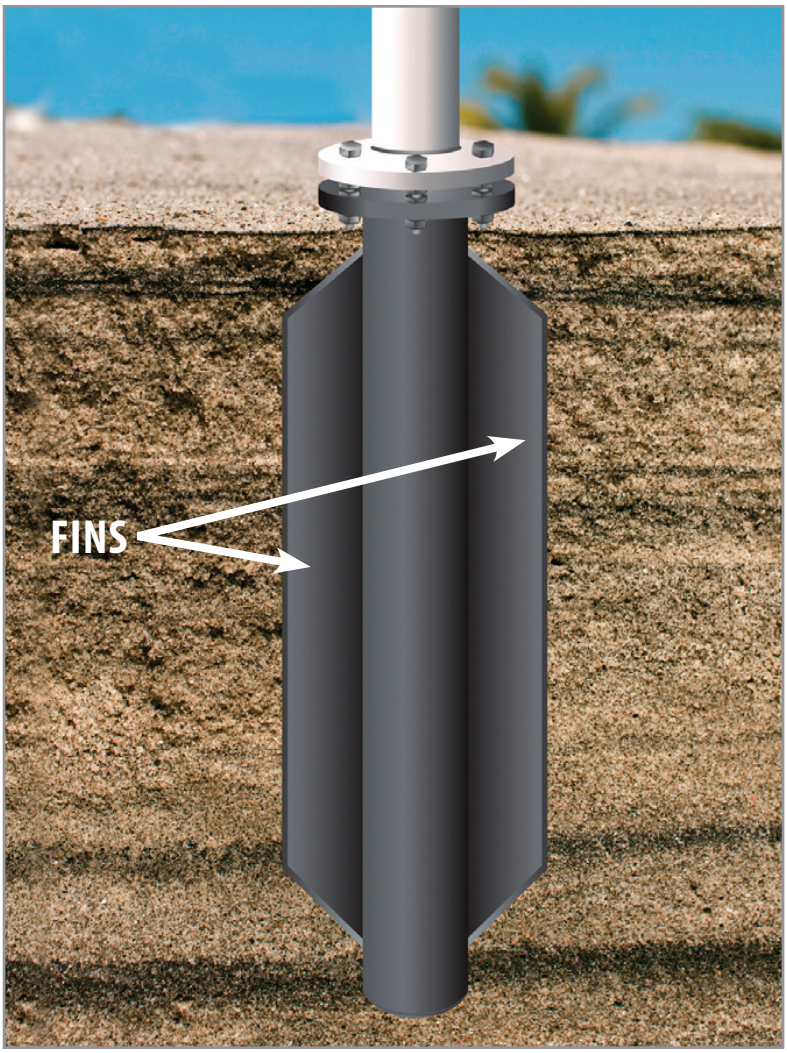
Driven piles offer schedule advantages over cast-in-place piles. Drilled shafts require time for the concrete to cure prior to bearing load. Accordingly, there is a time lag between when the foundation is installed and the structure is erected which adds time to the overall construction schedule. Drilled shafts are also typically more labor and equipment intensive to install. Steel piles and precast piles, once placed, can have the superstructure erected immediately. Accordingly, structure erection can typically occur faster after driven pile installation compared to drilled shafts.

SHANER INDUSTRIES' METAL FOUNDATIONS

Structural steel piles offer significant flexibility when compared to other deep foundation elements. One advantage is their strength without the use of reinforcing elements. Other advantages include simpler and faster installation and the potential for an integrated superstructure and foundation.

Shaner Industries metal foundation elements are innovative structural steel displacement piles. A typical metal foundation element consists of a structural steel pipe with fins. The purpose of the fins is to accommodate lateral and torsional loading requirements. The configuration of the fins is determined based on site conditions, loads, and deflection requirements. ***Shaner Industries' metal foundation elements generally have improved load deformation performance when compared to conventional pipe piles or concrete piles of the same diameter.*** The piles are shop fabricated with the fins and shipped to the site.

The pile is installed using a proprietary hydraulic system that is mounted on the boom of a track mounted excavator or other similar equipment. The driving head consists of a product-specific mounting head (chuck), hydraulic cylinders for pushing, and a combination of various equipment deemed necessary by Shaner Industries' proprietary design system. If necessary based on project site conditions, an auger can be utilized below the driver to pre-drill in advance to facilitate installation.



SHANER INDUSTRIES' METAL FOUNDATION APPLICATIONS

Shaner Industries' metal foundation elements can be used in most applications where traditional deep foundations are used including for landslide stabilization. Shaner Industries' metal foundation elements can also be used for specialty applications where lateral load resistance and deformation are key considerations including:

- Solar Arrays

- Border Fencing

- Highway Signs / Poles

- Airport Lighting

- Conveyor Systems

- Communication Towers / Poles

- Power Transmission and Distribution Towers /Poles

- Small Wind Turbines

Shaner Industries' metal foundation elements are also ideal for applications where foundations must be installed and put into service quickly, for remote sites inaccessible by specialized equipment needed to install other foundation types, and for sites where specialized equipment might not be available.

Examples of these types of applications include:

- Disaster Recovery and Reconstruction
- Temporary Military Installations
- Projects in Foreign Countries

COMPARISON TO OTHER PILE TYPES

Below is a table comparing traditional pile types and Shaner Industries' metal foundation elements:

CONSIDERATIONS	PILE TYPE			
	Shaner Industries Metal Foundation	**Structural Steel**	**Precast Concrete**	**Drilled Shaft**
TYPICAL LENGTH (FT)	Up to 50	40-100	40-50	10-100
DISADVANTAGES	• Corrosion vulnerability • May be damaged or deflected by obstructions	• Corrosion vulnerability • May be damaged or deflected by obstructions	• 28-days required to reach strength • Difficult to handle and ship • Typically high breakage rate • High initial cost • Considerable displacement • Difficult to cut or splice • Relatively heavy	• 28-days required to reach strength • May require casing during drilling to address ground water or caving soils • Can be difficult to bypass obstructions • Potential safety hazard during installation due to presence of open hole prior to concrete placement • Requires specialist operator to run drilling equipment
ADVANTAGES	• Fast Installation • No excavation spoils • Can be quickly moved and reinstalled if damaged during installation • **Positive lateral deflection and torsional resistance** • **Easily removed if site restoration is a requirement of decommissioning** • Installation not impacted by groundwater or caving soils • Relatively light weight and easy to ship and handle	• Fast Installation • No excavation spoils • Can be quickly moved and reinstalled if damaged during installation • Installation not impacted by groundwater or caving soils • Relatively light weight and easy to ship and handle	• High capacity • Corrosion resistance • Hard driving possible • Installation not impacted by groundwater or caving soils	• High capacity • Corrosion resistance • Can be extended if required bearing surface is deeper than expected
REMARKS	• **Can be installed on flat or sloping terrain with a conventional wheeled or tracked excavator fitted with driving head**	• Requires a crane for installation, which can be difficult on sloping terrain	• Requires a crane for installation, which can be difficult on sloping terrain	• Requires a large specialized right for installation, which may be difficult to operate on sloping terrain. • May require a crane to set rebar and a concrete pump if location is inaccessible by the concrete truck. • Can be time consuming to install
INSTALLATION CREW MAKE-UP	• Equipment operator • Laborer to plumb and guide pile	• Equipment operator • Laborer to plumb and guide pile • May require operator for diesel engine powered driving hammer	• Equipment operator • Laborer to plumb and guide pile • May require operator for engine powering driving hammer	• Equipment operator • Laborer to plumb drill rig • Ironworkers to tie rebar

FOUNDATION CONSTRUCTION COMPARISON

Below is a comparison of construction tasks necessary to install Shaner Industries' metal foundation elements were compared to other foundation types:

TASK REQUIRED	CAST-IN-PLACE	PRE-CAST	DRIVEN METAL FOUNDATION
Stakeout	YES	YES	YES
Site Clearing and Excavation	YES	YES	**NO**
Pile Drilling and Casing *(if needed)*	YES	NO	**NO**
Fabricate and Install Rebar	YES	NO	**NO**
Place Concrete	YES	NO	**NO**
Cure Concrete	YES	NO	**NO**
Pile Installation Inspection	YES	YES	YES
Form Pile Cap	YES	YES	**NO**
Install Cap Rebar	YES	YES	**NO**
Place Cap Concrete	YES	YES	**NO**
Cure Concrete	YES	YES	**NO**
Install Anchor Bolts	YES	YES	YES
Test Concrete	YES	YES (in plant and for cap)	**NO**
Strip Cap Forms	YES	YES	**NO**
Backfill Caps to Grade	YES	YES	**NO**
Erect Superstructure	YES	YES	YES

The above chart demonstrates that significantly fewer tasks are required for Shaner Industries' metal foundation elements, which can significantly reduce he construction schedule and associated costs.

CONCLUSIONS

Several types of deep foundation systems are available for structural support. Many factors influence the ultimately selected foundation type. Shaner Industries' metal foundation elements offer exceptional flexibility in terms of modifications for structural purposes, such as fins to accommodate torsional loads, and for additional functionalities, such as an integral subsurface barrier for a border fence. Shaner Industries metal foundation elements are also suitable for a wide range of soil conditions. Properly applied, implementation of a metal foundation element results in a reduced construction schedule and an overall reduction in project cost when compared to traditional deep foundation systems.

ABOUT THE AUTHOR

Michael L. Schumaker, P.E. is the Manager of Civil Engineering for Venture Engineering & Construction, Inc. He has a Master's Degree in Civil Engineering and more than 19 years of geotechnical and civil engineering experience on a variety of projects.

Mr. Schumaker is a registered professional engineer in 11 states and has worked on projects in Europe and the Middle East. He has designed, performed and managed numerous geotechnical investigations. Mr. Schumaker has also developed recommendations and conducted detailed analyses for the design of various types of foundation systems.

Mr. Schumaker's experience includes development of construction plans and specifications for deep foundations and pile load tests. He also has significant experience related to foundation construction, load test execution, and construction quality control. Mr. Schumaker is a member of the American Society of Civil Engineers (ASCE) and the Deep Foundations Institute (DFI).

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