The advantages of steel sheet piling

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Introduction

Steel sheet piling (SSP) is a hot-rolled structural shape with interlocks on the flange tips. The interlocks permit individual sections to be connected to form a continuous steel wall which is earth-tight and water resistant. Because it is readily available and transportable, SSP is in many cases a fast and economical solution to an owner's need for a durable, long lasting wall system. Applications are far-reaching, and include, for permanent construction, retaining walls, bulkheads, bridge abutments, graving docks, cut-off walls, mooring dolphins and pier protection cells. Common uses also include temporary structures, such as trenches, cofferdams for building excavations, bridge piers, and lock and dams on the inland river system. At the end of the project, the steel sheet piles can be extracted, and the steel reused.

Hot rolled steel sheet piling is an engineered product meeting one of several applicable ASTM specifications. These specifications, combined with the SSP producer's quality control programme, provide a quality product which is ductile, durable and long-lived. In fact, construction in West London, UK, recently unearthed steel sheet piles over 80 years old. When pulled from the native wet soil, the piles were so well preserved, the original mill marks could be seen. Steel pilings in continuously submerged conditions tend to have relatively low corrosion rates, because oxygen levels decrease with depth. Steel pilings are also a zero-waste product: after extraction, they can be reused or 100% recycled.

Considerations in choosing steel sheet pile

The most common SSP end use is for sections that resist bending moment. These applications include retaining walls, cofferdams and other structures where lateral loads impart bending stresses into the structure. This requirement for beam strength, or section modulus, is provided by Z-profiles and U-profiles. Although the installed cross-section of a SSP wall constructed of Z-profiles and that of U-profiles is similar, the individual pile shapes differ, as does the location of the interlocks, both of which may impact the structural characteristics of the resulting structure. Although SSP is more typically used to carry lateral loads from soil and water pressures, sheet piling can also be designed to carry both lateral and vertical loads.

Straight or flat web, steel sheet piles are used to form circular cells that are filled with granular soil. The fill pushes-out against the sheeting and places the interlocks in tension. In this application, therefore, it is the interlock strength rather than the section modulus, which is the most important design parameter. These cells may function as single structures such as mooring cells or bridge pier protection cells. They are commonly connected together with arcs to form continuous walls to function as bulkheads, cofferdams, and similar structures.

Because the interlocks of hot-rolled sheet piling are water-resistant, products are available to seal the interlock and reduce or eliminate seepage through the interlocks. These products are commonly used in applications such as cut-off walls under

Steel sheet piling form continuous walls that are earth-tight and water resistant.

hydraulic structures in locks & dams, and for cut-off walls at hazardous waste sites.

The chosen pile section also needs to be strong enough to be driven through the various soil strata to the required penetration depth. The drivability of a piling section is a function of its cross-sectional properties, length, the steel grade used and, in some cases, the installation method used. The cross-sectional properties are available from the SSP producer, and vary with the section's thickness, depth, width, and shape.

Materials

Hot-rolled sheet piling is produced to meet one of several applicable ASTM specifications. Most sheet piling is currently produced to ASTM A 572, *Standard Specification for High-Strength Low-Alloy Columbium-Vanadium Structural Steel*, Grade 50, but may also be available in Grades 60 and 65 (comparable to S 355 GP). Additional specifications typically apply to specific applications. For example, ASTM A 588, *Standard Specification for High-Strength Low-Alloy Structural Steel with 50 ksi [345 MPa] Minimum Yield Point to 4-in. [100-mm] Thick*, is used for atmospheric weathering applications. For increased corrosion resistance in the splash/tidal zone in marine environments, SSPs can be produced to meet ASTM A 690, *Standard Specification for High-Strength Low-Alloy Nickel, Copper, Phosphorus Steel H-Piles and Sheet Piling with Atmospheric Corrosion Resistance for Use in Marine Environments*. Like A 572-Grade 50 steel, A 690 has a minimum yield strength of 50 ksi. Although no longer commonly produced, ASTM A 328, *Standard Specification for Steel Sheet Piling*, with a minimum yield strength of 269 MPa (39 ksi), is the original ASTM sheet piling specification.

Accepted engineering practice is to design steel sheet pilings to 0.65 F_y in longitudinal bending. This applies to Z-profiles and U-profiles. When designing cellular structures, accepted engineering practice is to limit the interlock load on the flat web sheet pile sections to one-half the minimum ultimate interlock strength.

Manufacturing

Steel sheet piling manufacturing relies on a method of steelmaking called electric arc furnace (EAF). In this process, scrap steel is charged into a furnace where electrodes melt the scrap to 1,922 K (3,000°F). During this first phase, carbon content is monitored closely to ensure compliance with the appropriate ASTM standard. After the carbon content has been verified, other elements, such as silicon, manganese, and are added to create the specific chemistry desired for the final product.

The process of manufacturing a steel sheet piling takes multiple passes from a steel blank or slab. The piling profile is formed at the same time the interlocks are formed. Piling is then cooled, straightened, cut to length and stored for delivery to the customer. Sheet piling lengths can range up to 30 m (98 ft) or more, depending on the section and manufacturer.

Environmental benefits

This manufacturing process is one reason steel sheet pile is very green. Because SSP producers obtain their steel from the electric arc furnace process, which utilises selected recycled steel scrap, they can produce steel to exacting specifications while utilising a scrap content of the finished steel in the range of 99 per cent. The manufacturing process itself has also been improved. In addition to being produced as a green product, sheet piles are installed in

Steel sheet piling is manufactured using 99 per cent recycled content.

Driving steel sheet pile displaces soil with minimal excavation requirements.

a manner that produces no spoils. Therefore, there is no risk of exposure and disposal of hazardous or contaminated materials. At the end of the structure's life, the piles can be extracted and either reused, if in good enough condition, or recycled. From cradle to grave, steel sheet pile is easy on the environment.

Installation

Detailed site investigation and evaluation allows the designer to determine the structural capacity of the underlying soil and potential structural loads on the steel sheet pile installation. Less obvious, however, is the impact of soil conditions on achieving quality steel sheet piling installations. A thorough knowledge of the site conditions enables an accurate assessment of both the topographical and geographical conditions.

The choice of a suitable driving system is of fundamental importance in order to ensure a safe and successful pile installation. Driving systems can be classified as either impact or vibratory. Impact hammers types include air, hydraulic, or diesel. Vibratory hammers clamp onto the top of the sheet piling sections and through a combination of vibration and hammer weight push the piling into the soil.

Steel sheet piles are installed by foundation contractors who specialise in pile foundations. It is very important that the contractor retained be experienced in using sheet piling. Steel sheet piling, as compared to a close-ended pipe pile, has a small cross-sectional area. It is, therefore, a non-displacement pile which does not cause soil heave or cause additional lateral pressures on nearby existing walls. Driven sheet piles displace soil rather than remove it; therefore the support of adjacent structures is not compromised due to soil movement. In addition, sheet piling will maintain its shape during installation.

ABOUT THE AUTHOR AND ORGANISATION

Jeffrey H. Greenwald, P.E., CAE is Executive Director of the North American Steel Sheet Piling Association where he directs programmes that provide education and training, communicate performance through case studies, promulgate technical and design data and to understand the needs of users of steel sheet piling. Greenwald's past experience includes being Vice President of Engineering and Product Development for the National Stone Sand & Gravel Association where he worked to establish the industry's research and development programme. At the National Concrete Masonry Association, Greenwald headed the Research and Development Laboratory and directed the research, testing and general functions of the laboratory.

Greenwald is a registered professional engineer in Virginia. He earned a master's of civil engineering degree from the University of Delaware and a Bachelor of Science degree in civil engineering from the University of Maine. He graduated from the Institute for Organizational Management with a certificate in Nonprofit Organization Management and is a Certified Association Executive (CAE). Greenwald is a member of the American Society of Civil Engineers, Deep Foundations Institute, Pile Driving Contractors Association, Construction Specifications Institute, American Society of Association Executives and ASTM. Greenwald has authored numerous journal articles and was awarded the ASTM Alan H. Yorkdale Memorial Award for 2004 and 2005.

Traditionally, steel sheet piling systems are used as major components in the construction of port facilities, bridges, locks and dams, remediation of contaminated soils, and support of excavation. Founded in 2003, The **North American Steel Sheet Piling Association (NASSPA)** is dedicated to providing information and guidance for the efficient design, construction and maintenance of hot rolled steel sheet piling systems. NASSPA's members represent the producers of hot rolled steel sheet piling that supply the North American market.

ENQUIRIES

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