CompositeZ SHEET PILE INSTALL GUIDE

WHAT IS PULTRUDED (COMPOSITE) SHEET PILING?

- Pultruded sheet piling is manufactured from a process utilizing high performance "space-age" composites. It has 2 primary characteristics:
    1. It is manufactured incorporating continuous fiber reinforced roving and matting combined with a high strength resin. The roving gives the sheeting its longitudinal strength and the matting, the desired transverse properties. The tensile strength of the roving itself is greater than most steel.
    2. These high strength fibers are then drawn through a "resin bath" and pulled through a heated die that cures the pultruded profile to its final "Z" shape. The final result is a solid, rigid, high strength sheeting profile with some of the most consistent tolerances available today.
- Manufactured with the worlds most widely accepted and trusted Domestic "ball and socket" interlock, this combined with its rigid "Z" profile, 1/4" thickness and 18" driving width results in what we believe to be the finest composite (pultruded) sheet piling available today!

Unlike most vinyl sheet piling which is simply a non-reinforced pvc (poly vinyl chloride) extruded into the shape of an interlocking sheet pile configuration, pultruded sheet piling is a fiber reinforced plastic (FRP) resin impregnated composite. The glass is actually "woven" in a pattern when combined the hardened with resin results in incredible material strength. The final product is a glass reinforced sheet piling with true structural integrity. The best (and most familiar) analogy is probably the "orange" ladders sold in any Home Depot™ or hardware store. The orange ladder rails (sides) of these ladders are not simply fiberglass coated with resin. These "orange" ladder rails are actually pultruded shapes with structural strength second to none.

Characteristics of Pultruded Sheet Piling

- Resistant to corrosion.
- Resists attack of marine borers and other destructive elements in the marine environment.
- High strength.
- Non conductive – thermally and electrically.
- Resists UV degradation.
- Life expectancy of 50 years-plus.
- Low maintenance.
- Lightweight (80% less than steel) – allows for easier installation, even setting by hand in many cases.
- Can cut with a circular saw – No burning.

Composite Zä Sheet Piling Uses:

Bulkheads/Seawalls – Commercial and Residential
Marinas
Dikes
Erosion Control
Jetties
Groins
Cut-off Walls
Soil Containment
Retaining Walls
Wing Walls
Trench Shoring
Floodwalls
Bank Stabilization
Golf Course Retaining Walls
Waste Containment

Manufacture

One manufacturer of pultruded profiles defines pultrusion as “the continuous processing of raw materials by pulling resin-rich reinforcements through a heated steel die to form profiles of constant cross section of continuous length.” The first reinforcement utilized in the profile are long continuous glass fibers referred to as “roving”. Glass roving runs the length of the pultruded profile and gives the shape its “longitudinal strength”. To add multidirectional reinforcement, continuous glass “matting” is added. The roving and matting is now pulled through a resin bath where the glass fibers are saturated with a liquid thermosetting resin. This process is typically referred to as the “wet-out” process. The coated fibers are now assembled to the proper shape by a forming guide and finally drawn through a heated (curing) die. Once exiting the die, the pultruded shape is cooled and the resulting high strength, reinforced composite sheet piling is cut to length.

ENGINEERING AND DESIGN

Strength of Pultruded Sheet Piling

Although the composition of Composite sheet piling is different from other material used in the manufacture of sheet piling, the strength of the sheeting can be computed using techniques common to all sheet piling. An understanding of the principles of sheet pile design is essential to the proper specification of any sheet piling material or section configuration. Sheet pile walls are generally designed to a) resist overturning due to lateral earth pressures and b) failure in bending due to the same lateral earth pressures. This section of the guide will deal primarily with (b); we will start with a general overview of bending moment and flexural stresses.

Bending Moment in Sheeting

The objective in specifying a section of sheet piling is to obtain sufficient resistance to bending moment. Allowable bending moment is computed by the formula

$$M_{allow} = Zs_{allow}$$

where

- M_{allow} = Allowable bending moment
- Z = Section Modulus
- σ_{allow} = Allowable Stress of the Material

Both the allowable bending moment and the section modulus are specified as per lineal foot or meter of wall. The section modulus is strictly a function of the physical shape of the material and the allowable stress of the material itself. Thus, the strength of sheet piling to resist bending is a combination of the shape of the section and the material out of which it is made.

Allowable Stresses in Pultruded Sheet Piling

Below is a chart showing the material properties of Pultruded sheet piling.

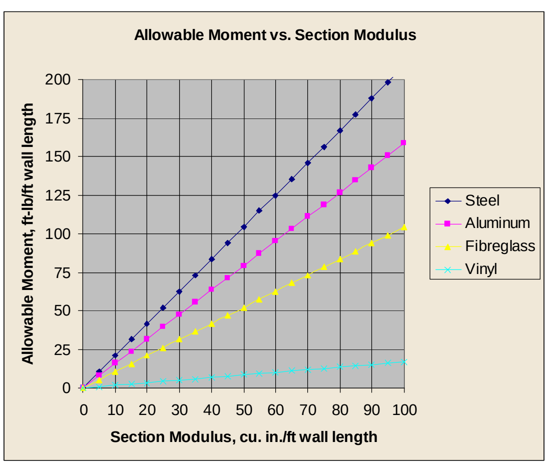
Mechanical Property	ASTM Test	Property, Parallel to Fibers	Property, Perpendicular to Fibers
Tensile Strength	D638	30 ksi	7 ksi
Tensile Modulus	D638	2,500 ksi	800 ksi
Compressive Strength	D695	30 ksi	15 ksi
Compressive Modulus	D695	2,500 ksi	1,000 ksi
Flexural Strength	D790	30 ksi	10 ksi
Flexural Modulus	D790	1,800 ksi	800 ksi

Full Section Modulus of Elasticity		2,800 ksi	
Notched Izod Impact	D256	25 ft-lbs/in	4 ft-lbs/in
Allowable Stress		12.5 ksi	2.3 ksi

The difference between the allowable stress in Pultruded sheet piling and the tensile strength and flexural stress is due to the factor of safety of 2.4 being applied to the tensile strength of the material in the direction parallel to the fibers. This results in the allowable stress in Pultruded sheet piling to be 42% of the tensile strength. This kind of factor of safety is customary for materials used in sheet piling. For example:

- Steel sheeting is generally designed so that the allowable stress is 65% of the yield stress of the material. For an ASTM A-328 material, this means that the allowable stress is 65% of the yield strength of the material, which is 38.5 ksi. This makes the allowable stress to be 25 ksi.
- Aluminum sheeting is generally designed so that the allowable stress is 50% of the ultimate stress of the material; this is similar to Pultruded sheeting. For 6061-T6 aluminum, which has an ultimate strength of around 38 ksi, the allowable strength is 19 ksi.
- Vinyl sheeting can have tensile strengths up to 7.5 ksi; however, due to long term creep concerns, most vinyl manufacturers have derated the allowable stress in vinyl sheeting to 2 ksi. However, even when this is ignored, the allowable stresses for vinyl are less than those for the pultruded sheeting.

These factors of safety are important in the proper configuration of sheet pile walls. They take into account both variables that are integral to the material being used and to the loading conditions in the application itself.



The chart to the left[1] shows the relationship between the section modulus and the allowable bending moment for a selection of sheet pile manufactured in (4) different materials, using the formula above. It can be seen first that, for a section with the same section modulus, sections manufactured from pultruded fiberglass have a higher allowable bending moment (by a factor of more than six) than comparable vinyl sections.

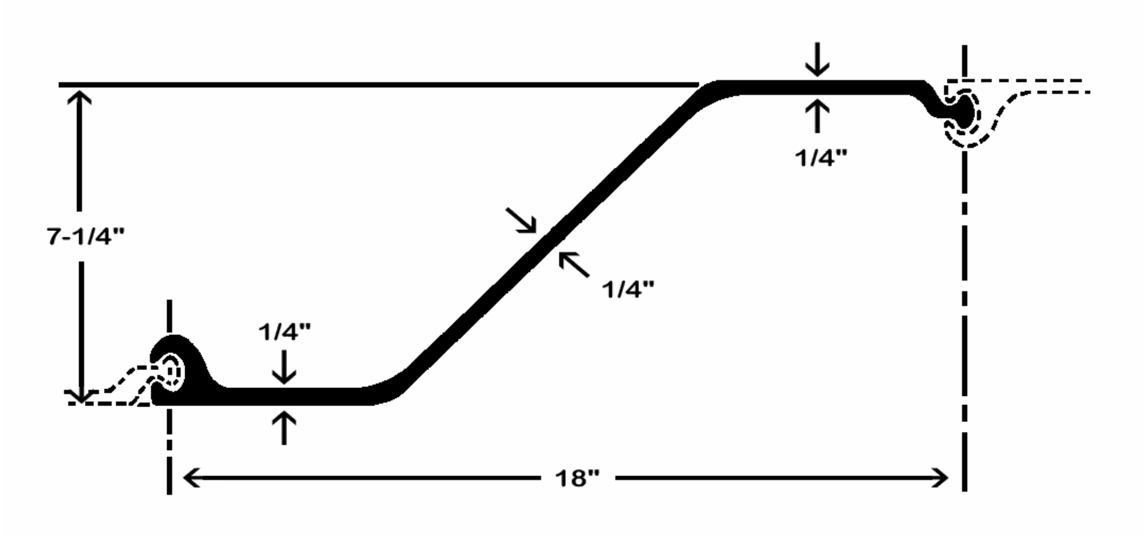
[1] The graph is only valid for comparing Composite Components Inc. fiberglass sheeting with other materials.

Structural Specifications for Composite Zä Sheet Piling

The specifications for P-100 pultruded sheet piling are shown in the table below.

Specification	Z-100	Z-200	SPW 911 Variable Designation
Shape	Z-100	Z-200	
Modulus of Elasticity	2.8 x 10^6 psi	3,000 ksi	E
Moment of Inertia per Unit Length of Wall	37.15 in^4/ft	64 in^4/ft	I
Section Modulus per Unit Length of Wall	10.25 in^3/ft	16 in^3 /ft	Z
Working Stress	12,500 psi	12,500 psi	f
Allowable Bending Moment per Unit Length of Wall	10,664 ft-lbs/ft of wall	NA	BM
Sheet Cross-Sectional Area per Unit Length	4.03 in^2/ft	4.9 in^2 /ft	A
Sheet Weight per section per Unit Length of Sheeting	4.75 lbs/ft	6.7 lbs/ft	W
Width of Sheeting Section	18”	18”	B
Thickness	.250”	.260”	-
Weight (per ln ft)	4.54 lbs/ft	6.7 lbs/ft	-

Additional information on the Z-100 sheeting profile can be found in the drawing below.



Composite Z-100 section

Application of Specifications to Allowable Bending Moment

The Composite Z™ section Z-100 has a section modulus of 10.25 cu. in./ft of all length. What is its allowable bending moment? And what other sections does it compare with?

First we need to compute the allowable bending moment. Since this material has an allowable stress of 12.5 ksi,

M_{allow} = (10.25 cu. in./ft)(12.5 ksi)/(12 in/ft) = 10.66 ft-kips/ft of wall.

The equivalent section modulus of other materials would be obtained by the formula

$$Z = \frac{M_{allow}}{s_{allow}} = \frac{(10.66)\left(12\frac{in.}{ft.}\right)}{s_{allow}}$$

a) Vinyl

Section Modulus for Vinyl = (10.68)(12)/(2 ksi) = 64.08 cu. in./ft

At the time of this writing, the largest section of vinyl sheeting available -- the Northstar 9400 - has a section modulus of 43.67 cu. in./ft. So there is no equivalent vinyl section.

b) Aluminum

Section Modulus for Aluminum = (10.68)(12)/(19 ksi) = 6.75 cu. in./ft. This is larger than, say, an AWL-135 section, which has a section modulus of 1.71 cu. in./ft.

c) Steel

Section Modulus for Steel = (10.68)(12)/(25 ksi) = 5.125 cu. in./ft. of wall section. This exceeds such sections as LZ5 (4.58 cu. in./ft.) and the L60 (4.97 cu. in./ft.)

In the case where the allowable moment is known, the chart can be used to compare the various types of sheeting to each other as well as the application requirements for each. Once the allowable moment is computed, the chart can be consulted and the section modulus required to resist that moment can be determined for the various materials.

These calculations are only for longitudinal bending. Situations where other considerations such as deflection (bending and shear deflection) and transverse bending should be considered separately.

DESIGN OF PULTRUDED SHEET PILE WALLS

Now that we have established the basics of the strength of Pultruded sheet piling, we need to discuss the actual configuration and design of the product.

Pultruded sheet piling is an engineered product. Although it is light weight (it can be manually picked up and set in many circumstances) and can be installed relatively easily, it is in fact load bearing and like all sheet piling, subject to failure if not properly configured. Thus, all of the care that is necessary for the design and configuration of other materials and shapes of sheet piling, such as steel sheeting, should also be given when the design of Pultruded sheet pile walls is carried out. This includes but is not limited to the use of a licensed, experienced professional to carry out the design work.

As mentioned earlier, sheet pile walls are primarily designed to resist overturning and failure due to excessive bending stresses. Both of these are addressed in established methods used to compute the strength and overturning resistance of sheet piling. These are described in such reference materials such as the *Pile Buck Sheet Piling Design Manual* and other reference books on the subject.

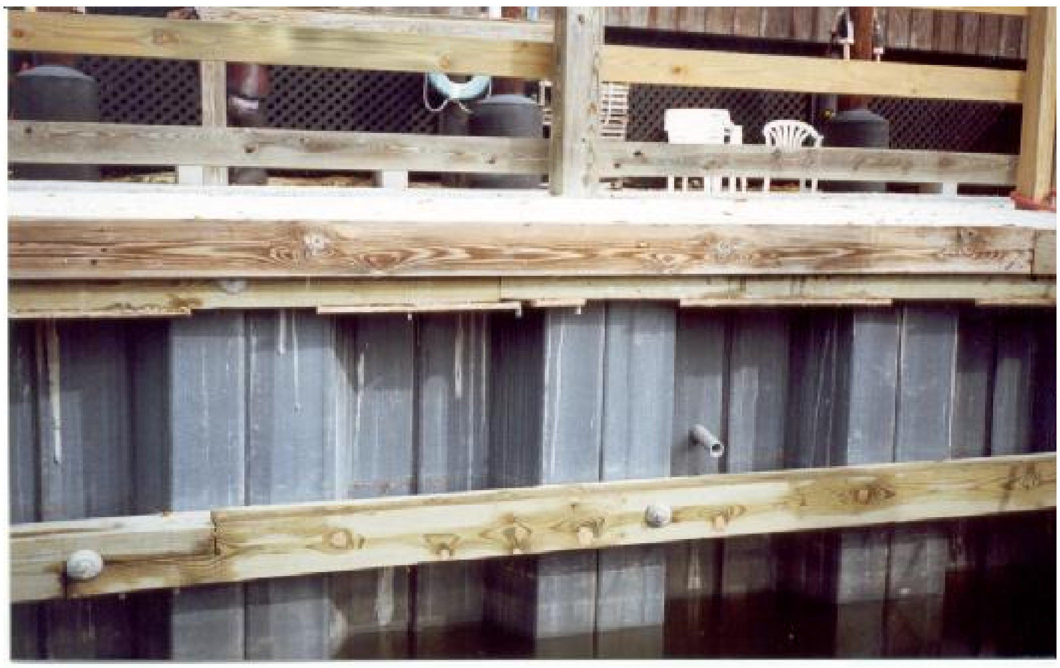
There are two methods currently employed to analyze sheet piling for moments and deflections: “classical” methods and finite element methods. Classical methods involve computing the lateral earth pressures on both sides of a sheet pile wall and then configuring the depth of sheet penetration suitable to resist overturning. They also are used to compute bending moments and deflections in the sheeting. Although they can and traditionally have been implemented using “hand” solutions, a faster approach is to use computer software such as Pile Buck’s sheet pile retaining wall software program *SPW 911 v. 2.01* to perform the calculations. A significant advantage of using this software is that multiple cases can easily be analyzed.

Both the design manual and the software are available from Pile Buck Inc. (www.pilebuck.com).

Finite element methods are relatively new for the design of sheet pile walls. These model the soil and pile by dividing both into small elements; a stiffness matrix is then developed and solved to determine the forces, stresses and deflections of the various elements. These methods should only be employed by those who are familiar with the use of finite element methods, not just sheet piling design.

Other important items of note concerning the design of Pultruded sheet piling are as follows:

- Deflection. Although stiffer than other non-metallic sheeting, Pultruded sheeting is still more susceptible to deflection than, say, steel sheeting. Designers need to insure that excessive deflections do not take place. Both of the methods described above, when properly employed, can be used to compute deflections. Also, the deflections shown here – and those of most methods used to compute deflections of sheet piling – do not take into consideration shear deflection, which is significant in short sections and more important in fiberglass than in materials such as steel. This should be checked independently with methods shown in any mechanics of materials text. *SPW 911 2.01* outputs values of wall shear, as shown below.



Local Buckling. In addition to the flexural stresses computed by conventional analysis methods as implemented by either hand calculations or *SPW 911 v. 2.01*, Pultruded fiberglass shapes – both the sheeting and the H-beams used in the wales – are subject to both compression flange buckling and lateral-torsional buckling. The former is a function of the geometry of the shape and the properties of the material; the latter includes the unsupported length of the sheeting. Although both of these situations can generally be avoided through the limitation of conventional deflection and bending stresses, the designer should be aware of these conditions. With the H-beams used in the wales, these can be factored into the calculations by use of the property tables available from the manufacturers of Pultruded H-beams and those enclosed herein, along in some cases with discussions of these conditions in general.

- Interlock strength. The description of the manufacture and configuration of Pultruded sheet piling should make it clear that the transverse strength of the material is considerably less than the longitudinal strength. Applications such as cofferdams where interlock strength is critical should be avoided with Pultruded sheeting.

- The type and compaction of backfill is critical to the success of a Pultruded sheet pile wall. Backfill should be made up of free draining cohesionless soil, compacted in layers. As is the cases with the design of any sheet pile wall, cohesive soils should be avoided as backfill to avoid rupturing the sheets when they expand with changes in water content.

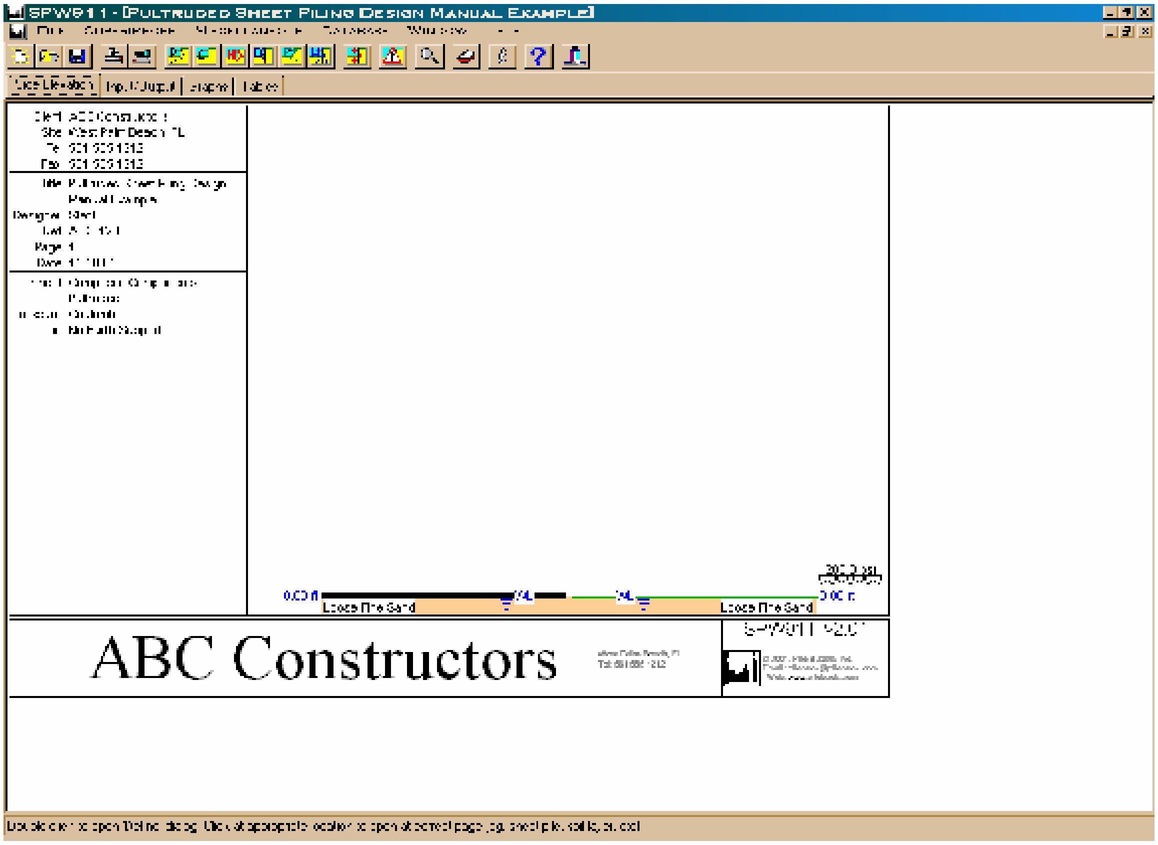
- Weep holes should be drilled into any pultruded sheet pile retaining wall to allow drainage behind the sheets that may occur during rapid changes in the groundwater level. The success of these weep holes is heavily dependent upon whether the recommendations previously mentioned for use of cohesionless soils in the backfill are followed. Weep holes are more effective if the soil is cohesionless and has high permeability. Holes should be a minimum 1-1/2" diameter with filter fabric and gravel filler material (1 cubic foot minimum) and be installed every 6' on center at 6' about the berm line or at MLLW. Weep holes in areas of wave action may also require protection at the outlet.
- Factors of safety should be similar to those used with other sheet pile materials.
- Sheet pile wall returns must be provided at the ends of all bulkheads/seawalls to prevent the possibility of flanking and/or washout.
- Any timber face and/or anchor piles used in a marine construction or saltwater environment should be specified using tip circumference in accordance with ASTM D-25. Preservative treatment shall be to AWPA Standards C-3 and C-18 as required.
- Although no sheet piling does well against rock, it is especially important to avoid rock with Pultruded sheet piling.

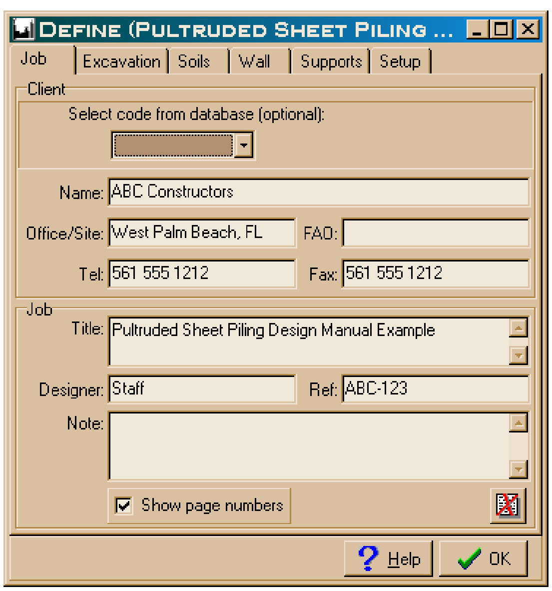
The layout of Pultruded sheeting is also similar to other types of sheeting. Careful consideration needs to be made to the sheet geometry and how it comes out in corners.

Sample Design of a Pultruded Sheet Piling Wall

Following is a sample design of a Pultruded sheet pile wall using SPW 911 v. 2.01. This is only a sample and should not be used for an actual design. We will present the results in a series of "screen shots" taken from an actual SPW 911 analysis to illustrate the data. However, although SPW 911 is used for this example, obviously hand calculations using classical methods or finite element analysis can be used for this type of sheeting.

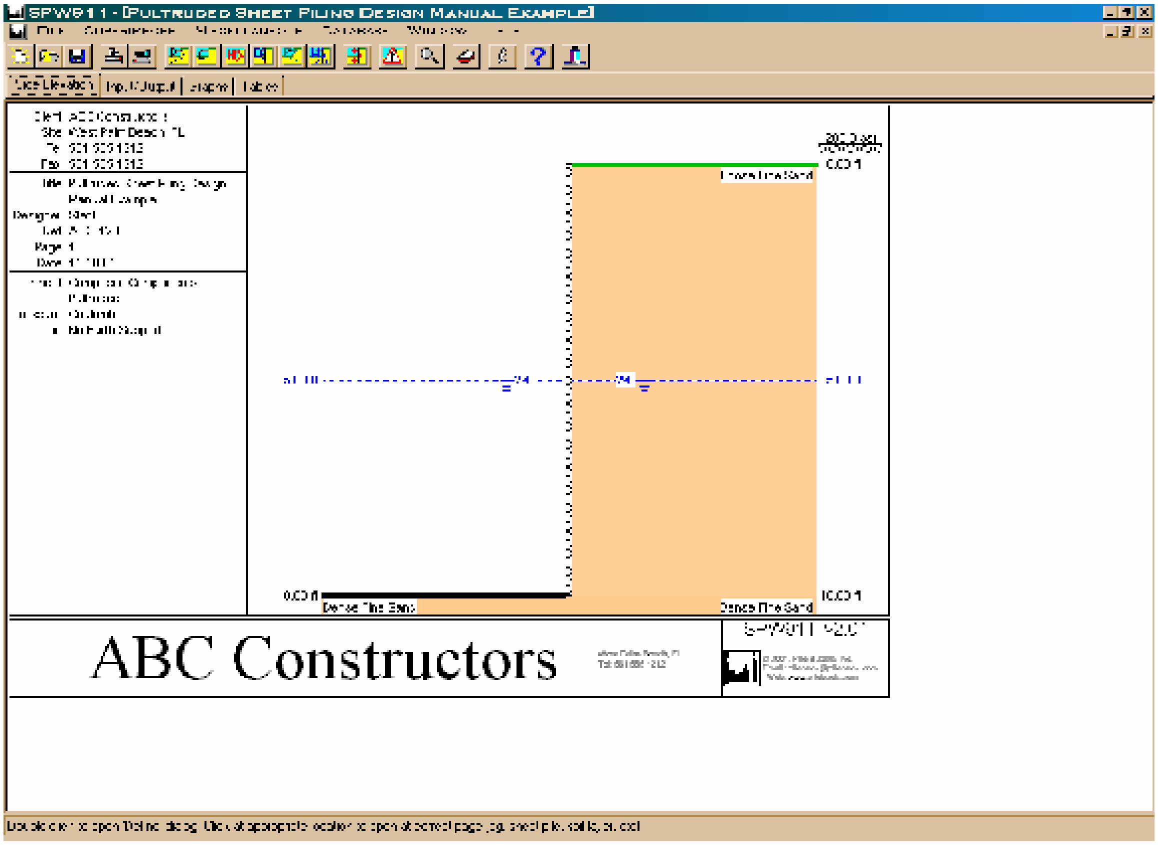
First, enter the basic contractor information into the program:

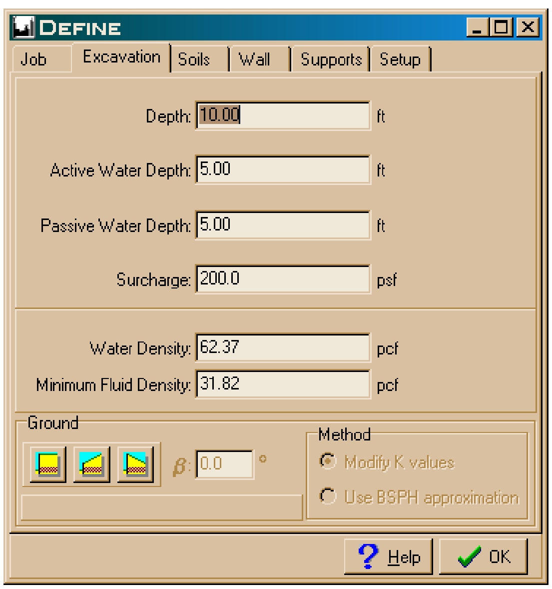




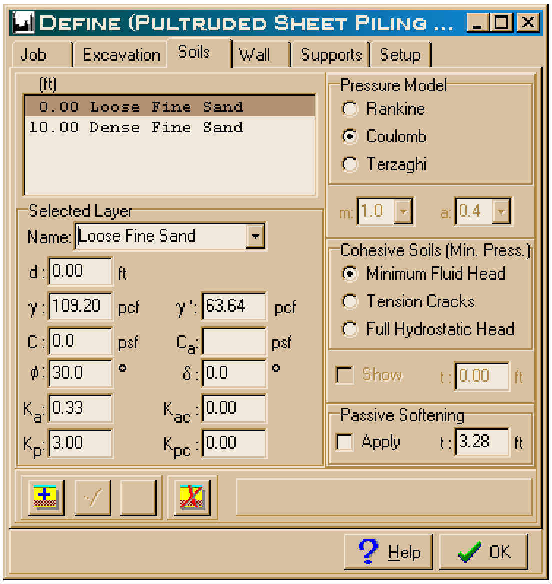
The input dialog for this is shown at the left.

Step 2. Input the basic excavation data.



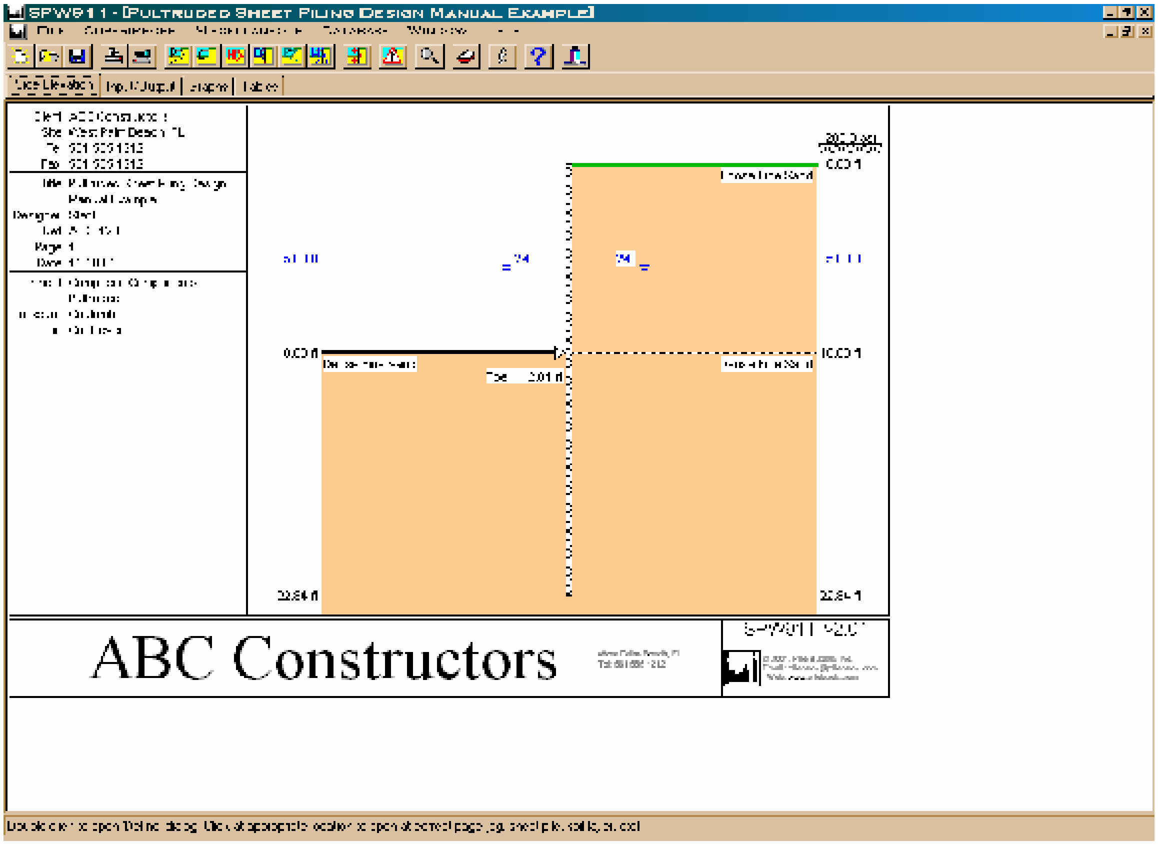


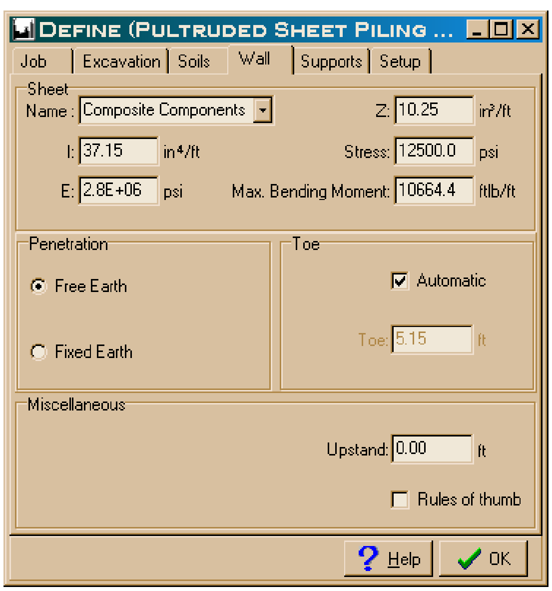
In this case, the design calls for an excavation of 10'. The water depth on the excavated side is 5', which means that the water depth from the top of the excavation/sheeting is 5' as well. The water table on the other side has the same depth as the water on the excavated side. There is a surcharge of 200 psf.



Step 3. Input the soils data. From ground level to the excavation depth of 10', the soil is loose fine sand; below this 10' mark, it becomes dense find sand. In this example the Columb theory of modeling lateral earth pressure is chosen as an option in Pile Bucks SPW 911 V2 sheet piling retaining wall software program. Alternatives would be the Rankine or Terzaghi pressure models or hand calculations.

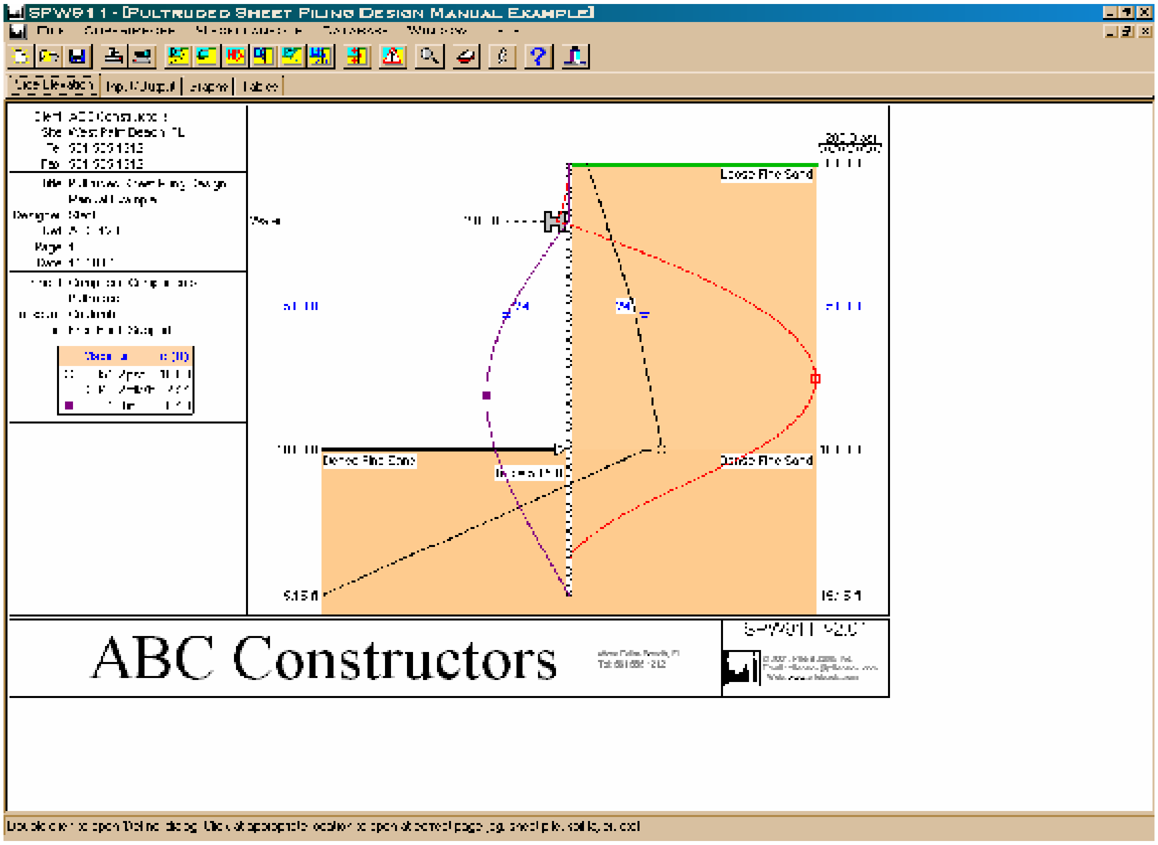
Next, input the sheeting data.

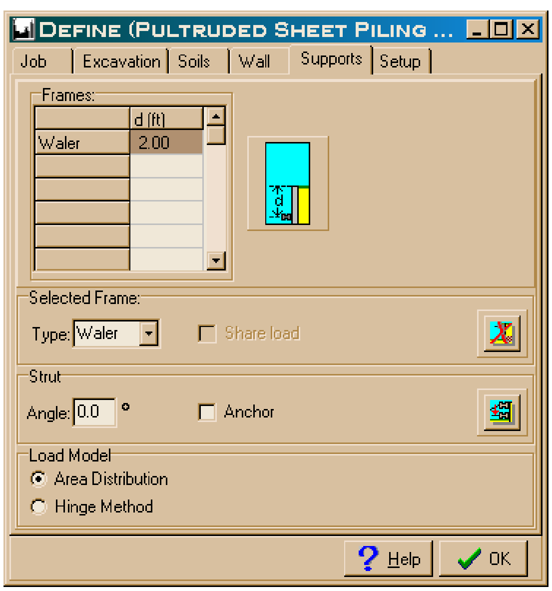




The sheeting specifications given above are in the order and format needed for their use in SPW 911, although these specifications are essential in any analysis of the sheeting.

Without wale design at this point, the program automatically assumes a cantilever design and designs a toe depth of nearly 13’ from the bottom of the excavation. This successfully resists overturning but has very unsatisfactory bending moment and deflection results. The wall in this configuration is not an acceptable design; wales are required. As a result, supports (wales) must be added.

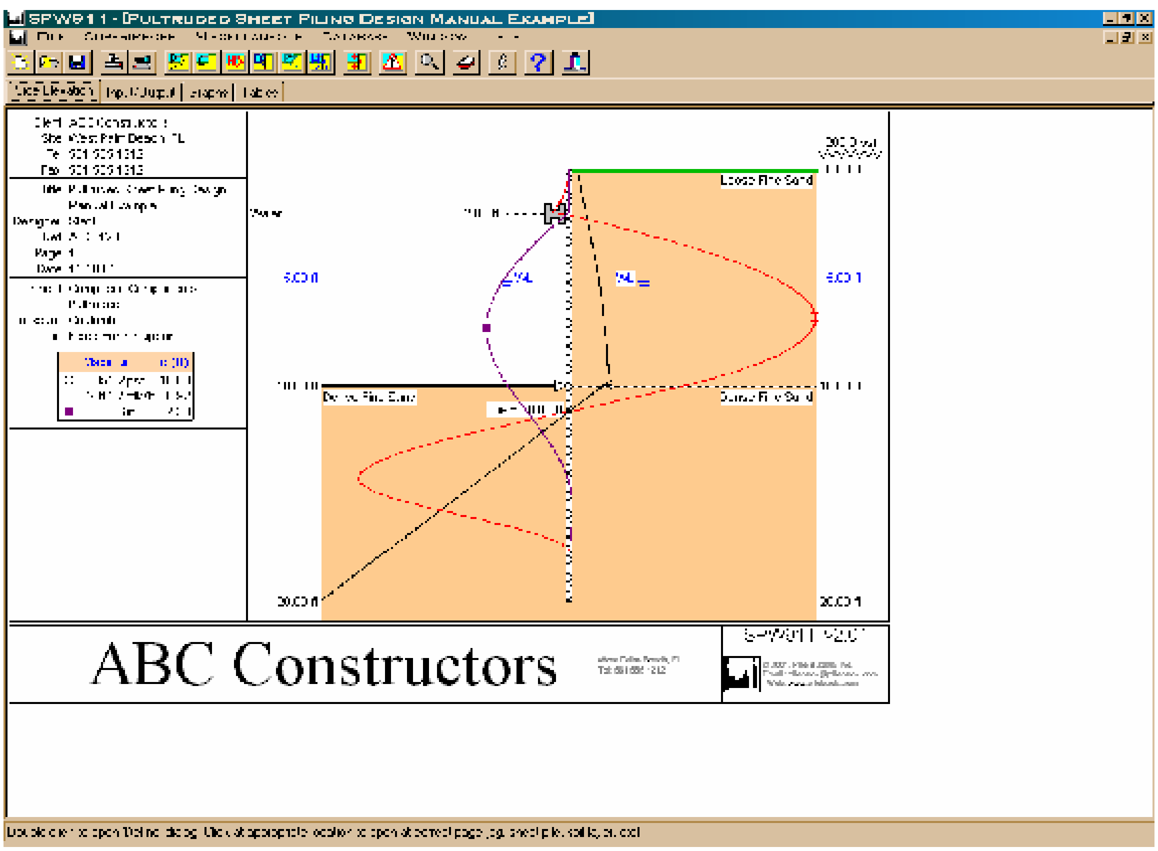




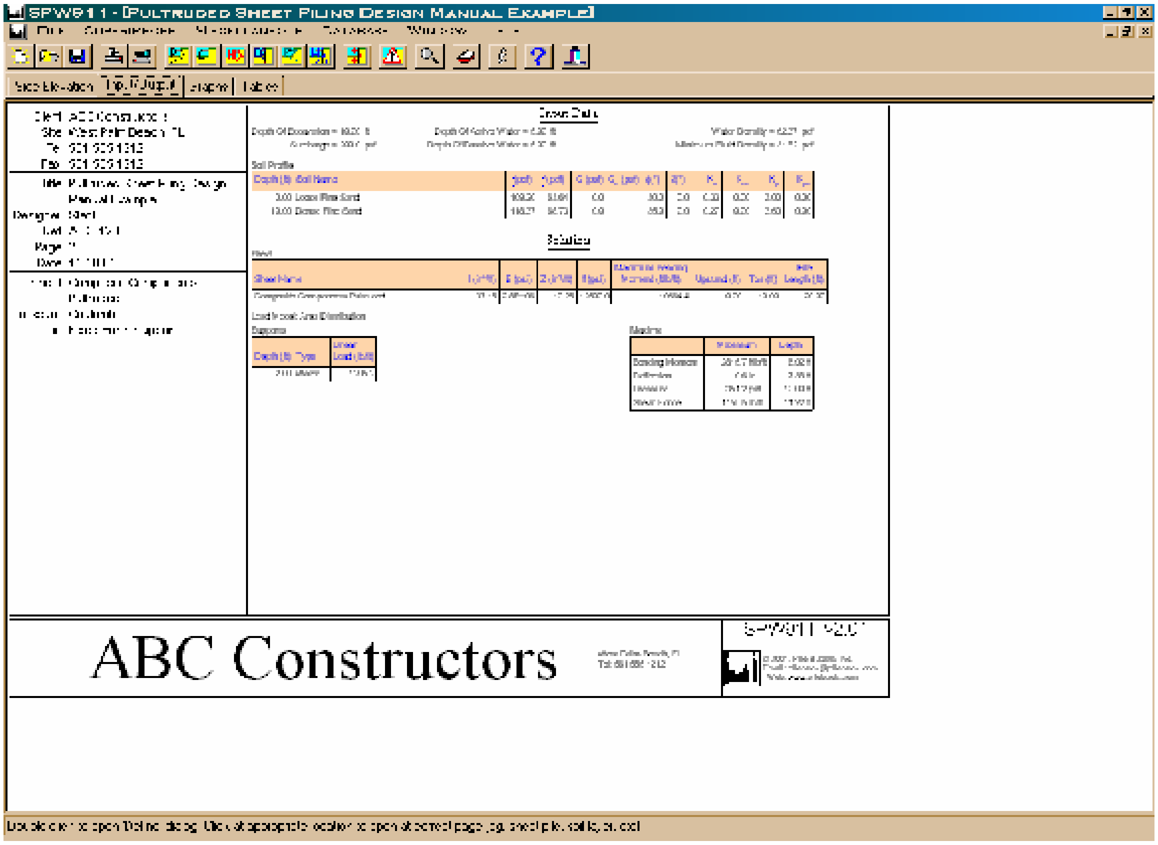
In this case a wale with tiebacks 2’ from the top of the wall is added. As a result, the bending moment falls to within the allowable bending moment of the pultruded sheet piling. It is important to carefully note the wale support load per unit length of wall, as this is essential in proper tieback design for any wall design.

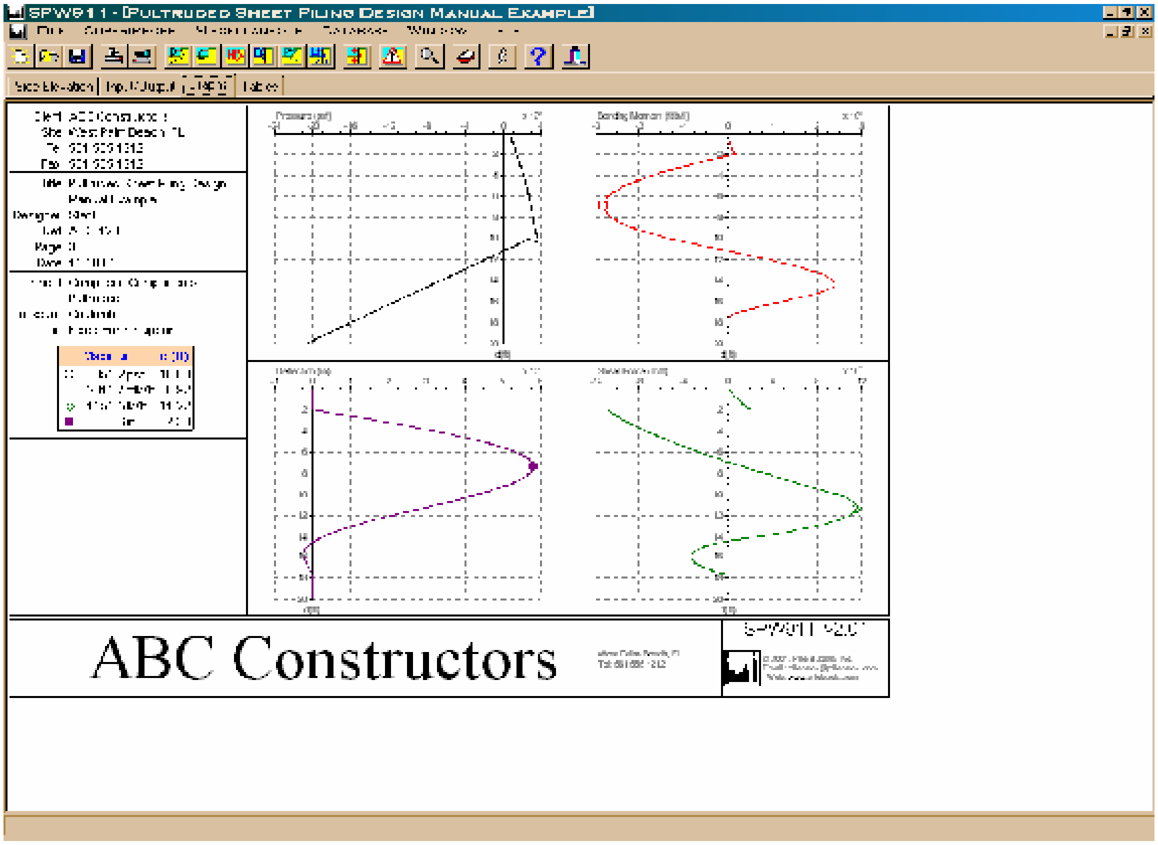
One thing that needs to be especially watched with the design of Pultruded sheet piling is the deflection. One method of decreasing the deflection of the sheeting is to drive it further into the ground. In this case we increased the toe depth from 5.15’ below the bottom of the excavation to 10’. As shown below, the maximum deflection decreased from 1.0” to 0.6”. Additional wales and tiebacks could also be used to accomplish this task. Also shown below is the pressure diagram along the wall.

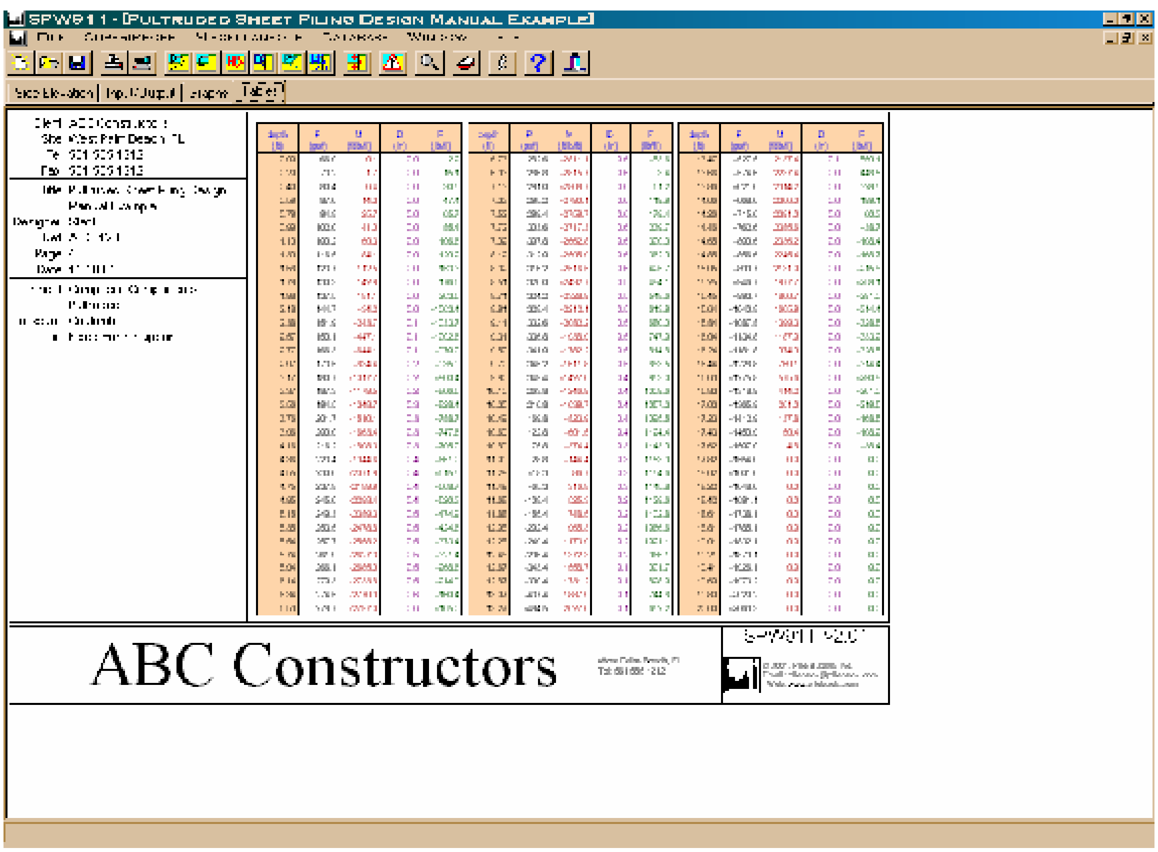
The deflections shown here are merely the results of calculations and are not meant to represent any property of the wall with regard to deflection. Maximum permissible deflection may also be influenced by other factors, such as connecting or neighboring structures. Also, the deflections shown here – and those of most methods used to compute deflections of sheet piling – do not take into consideration shear deflection, which is significant in short sections and more important in fiberglass than in materials such as steel. This should be checked independently with methods shown in any mechanics of materials text. *SPW 911 2.01* outputs values of wall shear, as shown below.



After this, we can see detailed results of input data, graphs and tables below.




SPW911 - [Pultruded Sheet Piling Design Manual Example]
ABC Constructors


SPW911 - [Pultruded Sheet Piling Design Manual Example]
ABC Constructors

It should be noted again that Pultruded sheeting is an engineered product and must be designed with the same care and expertise that other engineered products should be.

Finally, we take a look at the same case if a competing fiberglass section is used. The basic results are shown below.

CUTTING & DRILLING PULTRUDED SHEETING

Pultruded sheeting is furnished cut to specified length. In most cases, however, it will be necessary to cut, or drill the material to complete the wall installation.

Cutting Pultruded Sheet Piling

The cutting or sawing of Composite Z™ Sheet Piling, cap and walers can be accomplished quickly and accurately with a circular power saw. Considering a retaining wall is built on site, a hand model with the proper blade, cutting a properly clamped and RIGID pultruded shape utilized by a capable individual should be effective.

For routine cutting, a carbide edged masonary blade works well. If doing a final "leveling off" of a pultruded sheet piling wall and the cutting will be extensive, a diamond edged blade will perform best. Remember, pultruded shapes are an "abrasive" material. Tungsten carbide or diamond-coated blades are recommended. An inventory of these should be maintained. When sawing relatively few pieces, a hacksaw blade is suitable. Hacksaw blades will break occasionally and as a result, an adequate supply should be maintained. Although an ordinary carpenter's saw can be used, frequent resharpening can slow down this method and not encouraged.

One problem that may be encountered with a circular power saw is that larger pultruded sections (e.g. walers/H-piles) cannot be cut in one pass due to the blade vs. wale size. This problem does not exist with Composite Z™ Sheet Piling. However, larger wale sections can present a problem. As a result, these sections can be sawed in two passes by sawing half the profile from one side, then cutting the remaining half from the other side Obviously this would be best performed prior to placement of the waler however can be accomplished in place by a skilled carpenter.

Important Notes when Cutting Composite Z ä Sheet Piling or Structural Components

1. Composite Z™ sheet piling and pultruded structural components are strong, however also elastic. As a result, rigid (stiff) support is required at all times to keep the pultruded shape from moving when making a cut. Without adequate

support pultruded sheet piling, as well as cap or wale sections, can shift and may cause edges to chip or result in an uneven cut. Proper support will also prevent any warping or twisting of the structural member. Clamps, tie-downs, and vices should be utilized before any section is cut. Remember, RIGID, STIFF SUPPORT IS REQUIRED FOR ALL CUTTING AND DRILLING APPLICATIONS!

2. Fiberglass is very abrasive. Whether it be a circular saw blade, hand or hack saw blade, drill bit or even punch, these tools will wear quickly. Maintaining an inventory of saw blades and other cutting and drilling tools is highly recommended.

3. In cutting and drilling operations, avoid excessive pressure. Operating the saw or drill with a "light" steady pressure will result in the best finished cut or drilled hole.

4. Avoid excessive pressure. Too much pressure can clog the saw blade with dust particles, creating unnecessary heat. This will shorten the cutting life of the blade or drill bit.

5. The speed in which one is cutting is extremely important when cutting pultruded sheet piling, cap or wale sections. If the edges begin to splinter, slow down. Slow, steady cutting speeds aid in smoother finished cuts.

6. Too much force can rapidly dull the tool. Frequent tool sharpening is common. Diamond-coated or carbide grit edge saw blades and carbide tip drill bits are recommended.

7. The greater the thickness, the slower the cutting or drilling speed. As a result and to aid in decreasing heat generated during cutting also use an appropriate "speed" when cutting or drilling. Cutting speeds should be moderately fast.

8. Water cooling can assist when cutting more than one piece or when thick "wale" profiles are to be cut. Water aids in reducing heat generated on both the tool as well as the profile being cut. In addition, water helps control the dust created when cutting or drilling.

9. Do not generate excessive heat in any cutting or drilling operation. Excessive heat softens the bonding resin in the fiberglass – resulting in a ragged rather than a clean-cut edge. Excessive heat can also burn resin and glass.

10. Shearing and punching requires specific knowledge and should not be performed on a pultruded shape if not administered by an experienced person. Moreover, punching or shearing shapes in excess of 1/8" thick is not recommended.

11. Adhere to standard industry, OSHA approved safety procedures. Namely the use of an OSHA approved dust mask as well as the appropriate eye protection. The appropriate attire may also be necessary as some workers may experience skin irritation during cutting or drilling operations.

Drilling Methods

Any standard cobalt or carbide tipped drill bit is excellent for drilling Composite Z™ sheet piling, caps and walers. In many cases a standard “twist bit” may be suitable for drilling smaller quantities of holes. Most pultruders recommend drilling at the same speed in which one would drill a “hardwood”. Just as with cutting operations, this should be done at a steady, light (but firm) evenly applied pressure.

Important Drilling Notes:

1. When drilling “tie-rod holes” (large diameter holes), a backup plate of wood or similar material will aid in preventing the hole from having a “splintered hole” on the reverse side. Many pultruders refer to this unwanted result as a “breakout”.

2. Drill slowly. Especially when drilling with higher speeds. Drilling speeds should take hole size and thickness into consideration. The thicker the profile the slower the drilling process.

3. When drilling holes for the riveting of lightweight components, always use the rivet manufacturers recommended hole size.

4. Holes in pultruded shapes are generally always “oversized”. Holes drilled in composite structurals are generally .002” to .005” undersize. For example, a 1/8” (3.175 mm) drill will not produce a hole large enough to allow a 1/8” bolt nor rivet to enter. As a result, a larger No. 30 bit will be required. This should be noted when drilling bolt holes for wale and/or tie rod hardware placement as well as any lightweight lighting or signage components to be riveted.

5. Just as in cutting operations “water cooling” will aid in any drilling operation by both cooling the bit, drill and profile being cut. In addition, dust is kept at a minimum.

6. Too much force will dull a drill bit, increase heat and hinder the drilling operation.

7. Excessive heat created during drilling operations can burn the resin and glass in the profile.

Sanding and Grinding Operations

Grinding is generally not recommended on composite shapes however may be necessary in certain situations. These may be to correct an inaccuracy in a cut, notching, recessing a “high area” or simply touching up an edge. When grinding, the dust created has a tendency to clog the grinding wheel and as a result, impede the process. In addition, heavy pressure may heat up and soften the resin. If grinding is required, use a medium coarse grit wheel as opposed to a finer wheel. Also, water as coolant is recommended.

Important Grinding Notes:

1. Grinding should be performed at relatively high speeds.
2. A medium coarse grinding wheel is best.
3. Use carbide grinding wheels applied at a light, (non heat generating pressure).
4. Remember to clean the grinding wheel regularly. It will become clogged very quickly.
5. If using sand paper, an open grit sandpaper on a high speed sanding wheel gives best results.
6. Water will help eliminate dust as well as heat build-up.

BOLTS, HARDWARE, ETC.

Composite Z^{TM} Sheet Piling and composite cap and wale components may be joined by using standard industry bolts, nuts, and OGEE washers. In seawall and marine applications these are generally galvanized or stainless. Remember, it is imperative that the use of properly fitting bolts as well as a larger diameter washer or plate (to help distribute the load) be utilized in any pultruded profile connection. This is extremely important particularly with regard to the wale and tie-rod installation.

Important Hardware Notes:

1. The most important note when bolting a profile wale section is to always use a larger diameter washer or plate. This will aid in distributing the bolt or tie-rod load.

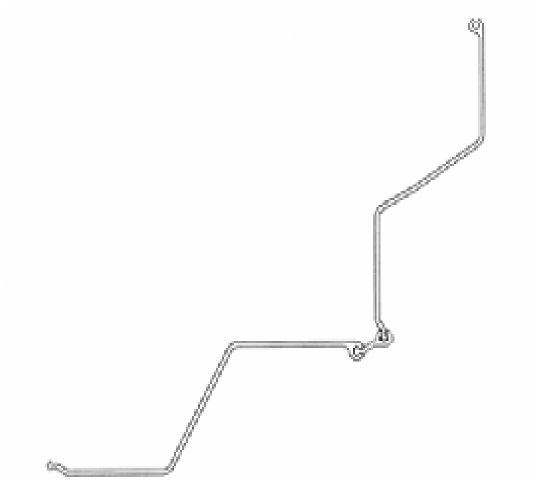
   *THIS IS EXTREMELY IMPORTANT WITH REGARD TO THE BOLTING OF A TIE-ROD ON A WALE SECTION!
2. Bolts, nuts, and washers may be stainless, galvanized, steel (in non-corrosive environments) as well as nylon, and other composites, bolts/rods.
3. Nails can generally be driven through 1/4" pultruded profiles, however will not hold when driven into a pultruded shape. Only wood. e.g. A pultruded shape can be nailed into wood however wood cannot be nailed into a pultruded shape as it will not hold.
4. Tapping is not recommended.
5. Consider carefully the use and design of fastening devices for mechanical connections of any composite structure.
6. Riveting of lightweight dock and seawall components such as conduit, lighting and signage is generally permitted. Obviously weight dictates suitable applications. Acceptable rivets are a) Nylon, b) "T", c) Drive (Nylon), d) Drive (Aluminum)

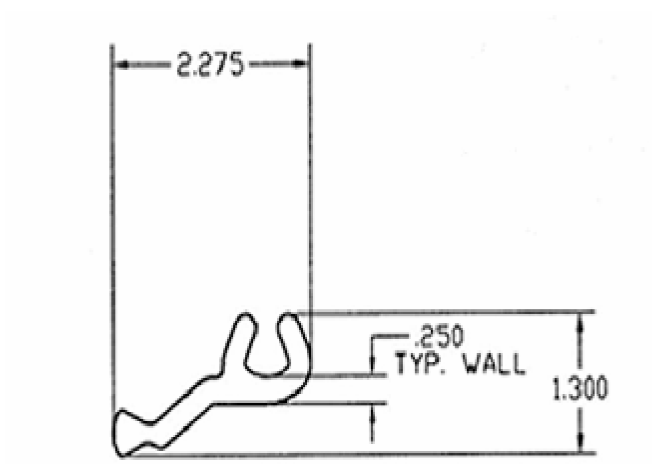
Marine and/or Saltwater Exposed Connections

Bolts, nuts, ogee washers, tie-rods, and other fasteners and/or connections should be hot dipped galvanized per ASTM A153 with 20 ounces of zinc per square foot. In lieu of galvanized hardware, if stainless steel fasteners are utilized they shall be of 300 series alloy stainless steel or have an equivalent protective coating such as a bitumastic. Any nailed connections should be stainless.

CORNER CONFIGURATION

90° Corner



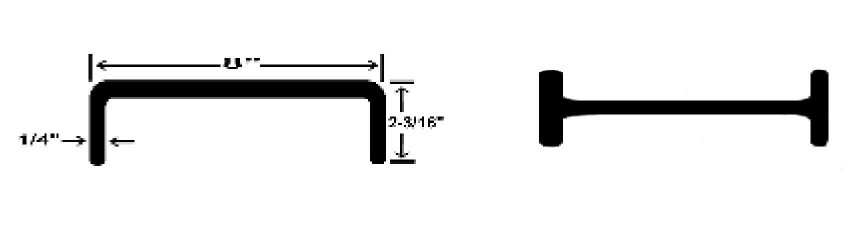


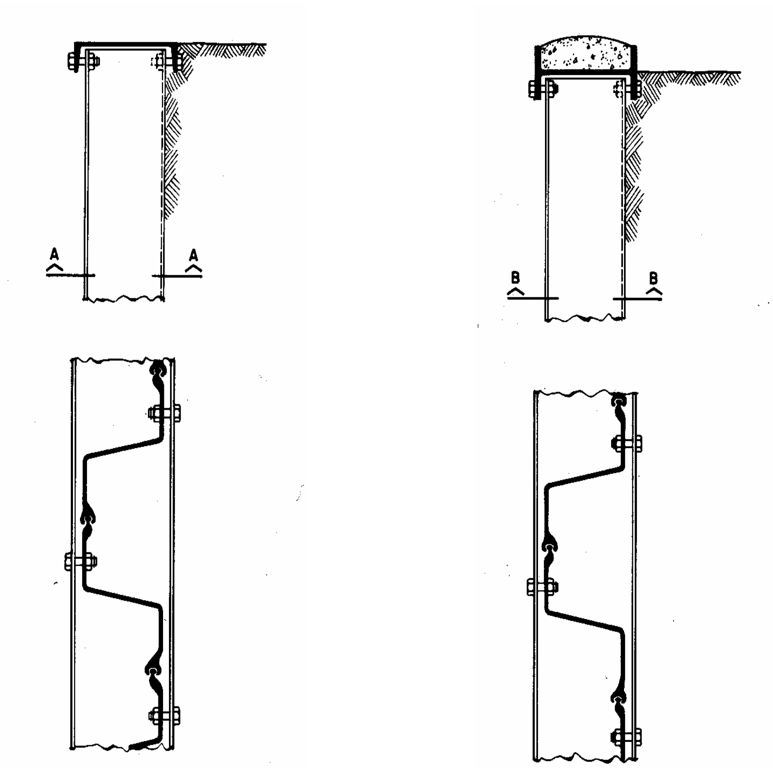
Composite Z corners are generally installed with the last "Z" sheet to be driven. e.g. The corner is hand threaded into the "Z" shape prior to setting the last "Z" shape in a wall prior to making a 90° turn or return wall. After setting this final shape combined with the 90° corner, the corner and the "Z" are driven simultaneously.

WALES, TIEBACKS AND CAPS

Caps

All permanent sheet pile walls need to be capped when installation is complete. Although this can be done with wood or concrete caps, we normally recommend the use of a pultruded channel cap. This piece is 8" x 2 3/16" x 1/4" and is customized to fit the sheeting profile. A drawing for this is shown below.





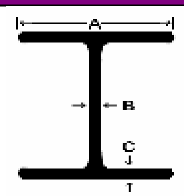
Wales

Virtually any installation of Pultruded sheet piling will include some kind of additional support for the wall. Although this support usually includes a tieback system, it always will include wales. Proper waling is extremely important in the design of a well engineered pultruded sheet pile wall. Lower walls can be strengthened with single waling but taller walls require multiple waling.

The most suitable waling for this application is Pultruded H-beams. These avoid the deterioration and environmental concerns of CCA treated wood wales. Composite H-beam walers are available in 6", 8", 10" and 12" sizes and are configured according to the design requirements and specifications shown below:

WALE (H-PILE) SPECIFICATIONS

SIZE	A, in.	B, in.	C, in.	I_{xx}, in^4	I_{yy}, in^4
12” x 1/2”	12	1/2	1/2	452.45	144.11
10” x 1/2”	10	1/2	1/2	256.20	83.42
10” x 3/8”	10	3/8	3/8	198.53	62.54
8” x 1/2”	8	1/2	1/2	126.96	42.74
8” x 3/8”	8	3/8	3/8	99.19	32.03
6” x 3/8”	6	3/8	3/8	40.17	13.52



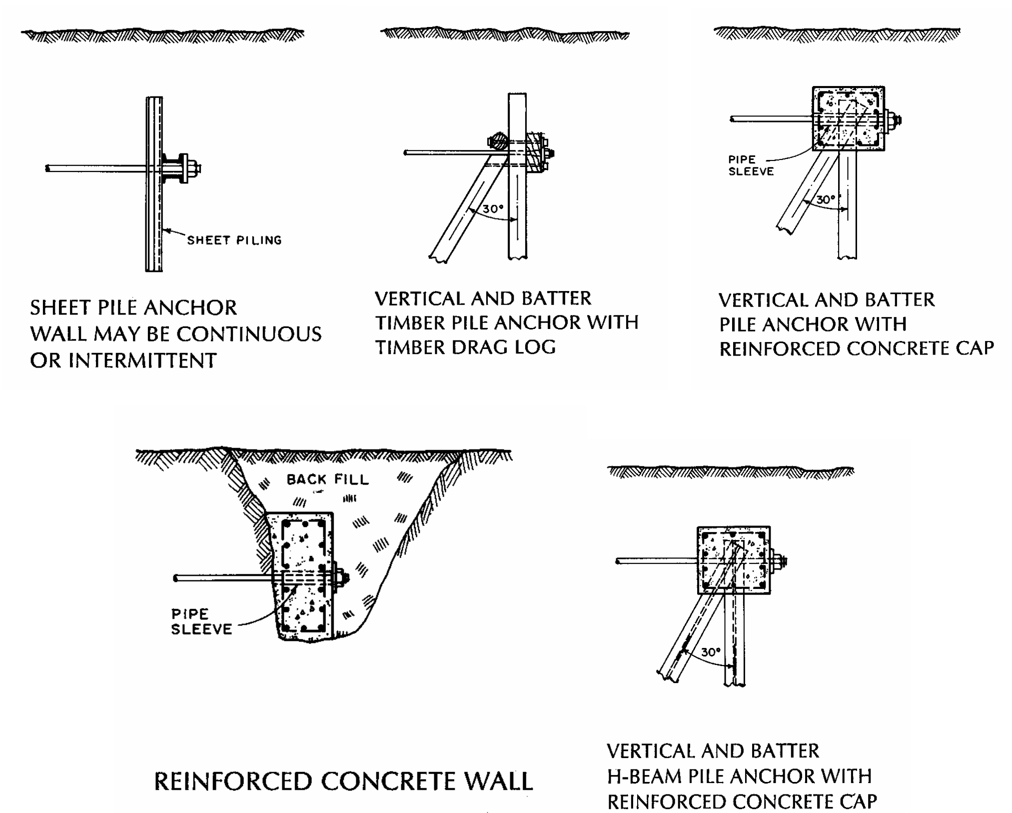
Although single wales are sometimes acceptable, in many cases due to the excessive height of a retaining wall double waling – or more -- is required.

Tiebacks

Tiebacks are essential to resist wall overturning when the wall is sufficiently tall for this to be a problem. Tiebacks consist of three basic components:

There are three recommended options to tie back Pultruded sheet pile walls:

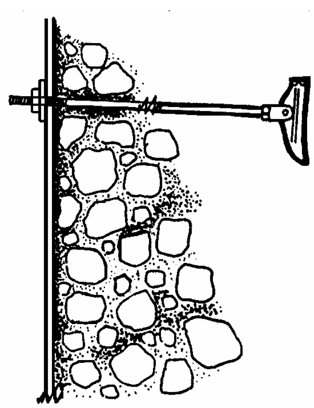
- Conventional galvanized or stainless steel tie-rod, washer and bolt systems anchored into a properly engineered “deadmen”, tieback wall, pile or other anchored device when properly engineered will be suitable. These consist of three basic components;
    - Tieback rod, which is generally a threaded, galvanized stainless steel rod cut to suitable length. For maximum corrosion resistance, an 18-8 stainless steel (300 series) should be used for these rods. Remember that these are completely buried so they are subject to deterioration due to groundwater, soil pH and other environmental agents.
    - Washers, bolts and other spacers to connect the tiebacks to the wales and thus the wall. These are threaded onto the tieback rods and tightened after suitable holes are drilled in the wall and wales.
    - Anchor for the tiebacks. This can be an anchor plate, pile or other type of anchor, depending upon the soil conditions and tieback pull loads. The tie rods are connected to the anchors.



(5) TYPICAL SHEET PILING BULKHEAD ANCHORING METHODS UTILIZING A CONVENTIONAL GALVANIZED TIE-ROD.

ADDITIONAL TIEBACK/ANCHORING

- Manta Ray® Anchor system – Manufactured by Foresight Products, LLC has an excellent anchoring system (similar to a "toggle bolt") as well as a 14 page guide to installing Manta Ray® anchors in retaining and seawall applications. A "hydraulic/load locker" device can give an immediate proof test of the installed anchor. Contact Composite Components, Inc. for the name of the nearest Manta Ray® Anchor distributor.



MANTA RAY® TIE BACK ANCHOR ASSEMBLY

- A.B. Chance Company - A Hubbell Company, the A.B. Chance helical tieback anchor (screw anchor) for tieback applications has widely been used throughout the industry in retaining wall, seawall, and bulkhead applications. It is an excellent anchoring system with a long history of successful applications. Like the Manta Ray system, it also can provide an immediate true load test of the anchor once installed. Contact Composite Components, Inc. for the location of the nearest A.B. Chance Company distributor.

A.B. CHANCE HELICAL TIEBACK ANCHOR ASSEMBLY

The design and spacing of the tiebacks depends upon the loading requirements. Spacing of the tiebacks is also influenced by the rigidity of the wales or top cap. If tiebacks are spaced too far apart, the wales and thus the wall will excessively deflect.

Note: Any of the above three options should provide for a structurally sound tied back anchoring system when properly engineered.

REMEMBER: A RETAINING WALL, SEAWALL, OR BULKHEAD IS ONLY AS STRONG AS ITS PROPERLY ENGINEERED WALE AND TIEBACK SYSTEM. ATTEMPTING TO ELIMINATE AN ADDITIONAL WALE OR INCREASING THE SPACING OF ANY TIE-ROD/ANCHORING DEVICE IN AN ATTEMPT TO SAVE MONEY WILL ONLY IN THE LONG RUN JEOPARDIZE THE STRUCTURAL INTEGRITY OF THE WALL AND IN THE END, RESULT IN FAILURE.

The results from *SPW 911 v. 2.01* or any other conventional method of sheet pile analysis will include the tieback loads in units of force per unit length of wall. The more tiebacks included in a system, the lower the load on each tieback.

INSTALLATION OF PULTRUDED SHEET PILE WALLS

Installation of pultruded sheet piling is similar to that of other types of sheet piling. Complete details concerning this can be found in *The Complete Book of Pile Driving*, available from Pile Buck. The following notes are some specific guidelines for Pultruded sheeting.

Pultruded sheet piling can be installed using a variety of equipment types, which include: Vibratory hammers, either excavator or crane mounted are the ideal tool for driving composite sheet piling. Vibratory plate compactors are also used, but these are exclusively excavator mounted and can damage sheeting tops if not properly operated.

- A portable air-compressor or hydraulic jackhammer with a sheet shoe.
- A drop impact hammer, either land-based or barge-mounted.
- A water jet driven by a high output pump, either manually held or suspended from a crane.

As with other types of sheet piling, pultruded sheet piling is best set before being driven. Because it is lightweight, when safety conditions permit it can be set in place by hand. It can also be installed with a crane or excavator if conditions require it.

The selection of an installation method is a matter of both jobsite conditions and contractor preference. However, as with any driven pile, the preparation before driving is frequently as important as the driving itself.

After the sheeting is driven, the wales, tiebacks, caps, etc. are to be installed. Make sure all recommendations in this guide concerning cutting, drilling, or any mechanical connections are followed during any or all of these operations.