A CLOSER LOOK AT THE USE OF SHEETING WITH HYDRAULIC SHORES

It is time to rethink the requirement for sheeting and how we train for it.

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Introduction

Aluminum hydraulic shores were first introduced in the United States around 1960, and became common within the industry around 1980. During that introductory period, most regions on the East Coast adopted a policy of placing the plywood sheeting first in the trench and then the hydraulic shore, whereas on the West Coast, the plywood was fastened to the shore and then the assembly was placed in the trench. In tabulated data for hydraulic shores, both **OSHA 1926 Subpart P App D – Aluminum Hydraulic Shoring for Trenches** and **manufacturer's tabulated data**, there are rules for when sheeting is required and when sheeting material is specified, but there are no specific rules on whether it should be placed separately or attached. This is in keeping with the OSHA policy of telling the user what they have to do but not telling them how to do it. For the suppliers, workers and trainers, it has caused several problems:

- Dual approaches and uncertainty about meeting OSHA requirements
- An abundance-of-caution approach to plywood sheeting that results in overuse and additional costs related to attaching the sheeting to the shores
- Additional labor costs associated with installing and removing the plywood on the hydraulic shore prior to shipping and in the field
- Very expensive additional cost in hauling hydraulic shores with plywood attached
- Environmental costs associated with trucking (air pollution), and the use of our natural resources (timber used in plywood)
- Plywood shelf-life reduction due to damage to plywood attached to the shores

This goal of this article is to clear up confusion and adopt a clear approach to the use of sheeting with aluminum hydraulic shores.

Understanding soil arching and the use of sheeting with hydraulic shores

In order to understand how hydraulic shores work and the role that sheeting plays in it, a person has to understand and believe in the principle of soil arching. Regardless of whether the soil moves first or the hydraulic shore is pumped out first, for there to be a failure, the soil has to move around and in between the support. In that process, soil particles form an arch between the supports that

prevents soil movement. In Figure 1, it is the sides of the bottle; in Figure 2, it is the strut or ends and the bottom of the trench. As long as there are two solid supports, the process will work. Hydraulic shores will not prevent cave-in unless there are at least two shores, or a shore and a solid soil bank to support the arch.

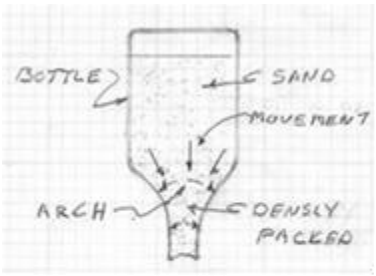

Figure 1-Soil Arching Principle

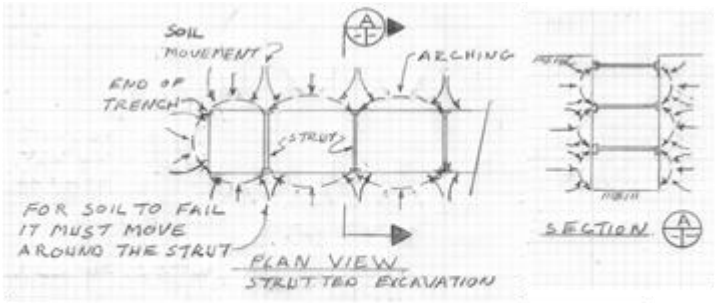

Figure 2-Soil arching between strutting or hydraulic Shores, and also to end of trench or

Arching works in both directions- vertically and horizontally. Karl Terzaghi described this process as the "transfer of stress from a yielding mass of soil to adjoining stationary parts." Hydraulic shoring is engineered and tabulated based on this principle, the strength of the cylinder, safe working load (21000 lb.), and soil load carried to it. Historically, the industry does not allow horizontal shore spacing greater than 8 ft. or vertical more than 4 ft. The sheeting has no place in this calculation. **In fact, the sheeting does not prevent cave-in.**

Soil arching is at work in many shoring applications. This brings us to the sheeting aspect of hydraulic shores. **The sole purpose of sheeting is to protect the worker from the effects of sloughing and raveling.** Sloughing relates to cohesive soils and raveling is associated with non-cohesive soils (sands and gravels). The "zone of tension" shown in Figure 3 is the space between the face of the trench, and the arch is not supported. This distance is roughly 1 ft. to 8 ft. of the support spacing. With non-cohesive soils, they can ravel out over time as they dry. Plywood protects the workers from having sand, gravel, and stones fall on them as they work. In cohesive soil, the term sloughing ("shed or remove") refers to the fact that as clayey soils dry, they can peel off and fall on the workers below. There is a time element here that should be considered when deciding to use sheeting. In pipeline work with rapid excavation and backfill, plywood most likely would not be needed.

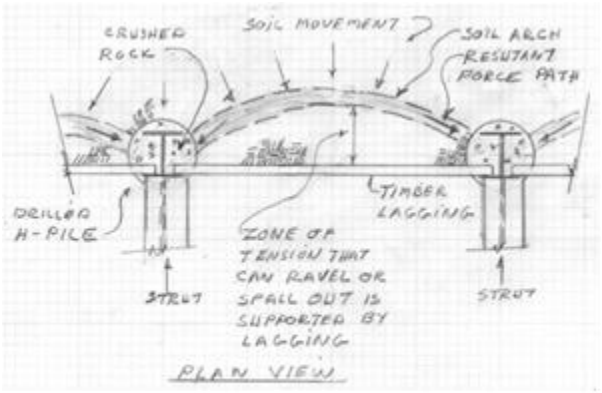

Figure 3-Zone of Tension

Besides sloughing and raveling, when hydraulic shores are used in C-60 soils over 10 ft., deep sheeting is **always** required. The reasoning behind this rule is not clear. When OSHA developed their rules for vertical hydraulic shores, they only allowed them in Type A-25 and B-45 soils. This was based on the concept that C-80 soil would not even stand up long enough to set the shore, and that soft clays could flow around the shores. C-80 sands have rounded particles that provide no friction, so the particles will roll out. Whenever water is present, the soil must be classified as C-80. As AHS production, sales and training accelerated in the 1970s, contractors found that there were many situations where soil that was not type A-25 or B-45 would stand up long enough to insert the shores. As a result, manufacturers of the shores invented a new soil type, C-60. This soil type is not recognized, confirmed, or denied by OSHA but they acknowledge it if it is identifiable to the Competent Person. The C-60 classification basically requires that the soil be dewatered to the bottom of the trench and stand up long enough to insert the shore. After the shores are installed, the arching effect kicks in to safely shore the trench. It makes sense, there is a lot of distance between 45 and 80 (stable and unstable).

How the plywood over 10 ft. requirement came to be is not clear. I know that when I tabulated AHS for manufacturers, I tried not to extend the limits of normal practice and tabulation. Eight ft. horizontal and 4 ft. vertical spacing was bedrock, but OSHA had nothing to say on sheeting as they had already removed the possibility of it in C-soil. Logic tells us that the possibility of sloughing and raveling would be greatly increased as the soil type degenerated. It made sense that after 10 ft. deep in C-soil, workers in the trench would become subject to rocks, sand, and gravel falling on their heads. This is where an “abundance of caution” came into play, and the requirement was born.

Suggested Training Approach

The decision about sheeting use with Aluminum Hydraulic Shoring should be quite simple:

- **Is there sloughing or raveling?**
- **Are we using the shores in C-60 excavations over 10 ft. deep?**

If the answer is no, move on. Plywood can always be added later.

If the answer is yes, use sheeting.

What does OSHA say about sheeting?

Here is the only thing OSHA has to say about sheeting in their Appendix D-Aluminum Hydraulic Shoring for Trenches:

> (7) Plywood shall be 1.125 in. thick softwood or 0.75 in. thick, 14 ply, arctic white birch (Finland form). Please note that **plywood is not intended as a structural member**, **but only for prevention of local raveling** (sloughing of the trench face) between shores.

It is amazing to me the amount of time wasted by engineers (myself included), trainers and inspectors trying to figure out the minimum strength the sheeting must be when OSHA clearly states that it is not a structural member. The Competent Person should be focused on the second part of this statement:

Does the sheeting prevent local raveling and sloughing?

Today, manufacturers in their tabulated data allow far more variations from "0.75 in. thick, 14 ply, arctic white birch (Finland form)", such as steel plate, 1-1/8 in. plywood decking, and other brands of plywood. As long as the sheeting prevents the material on the sides of the trench from deteriorating and raining down on the workers, the door should also be open to other materials including filter fabric draped over the top and sides of the trench wall.

OSHA Appendix A-Soil Identification has no definition or description for sloughing or raveling nor do they have tests for how to identify it.

Concepts for teaching about the use of sheeting with a hydraulic shoring:

Teach how to recognize sloughing and raveling. Think of sloughing and raveling as degradation of the soil at the trench wall between the shores. The process is the result of soil drying out due to exposure to air and temperature. As the material dries out, cohesive soils flake off and non-cohesive soils shed particles (sand and rocks) that can fall onto the workers in the trench.

- Sloughing and raveling develops over time after the trench wall is excavated. Pipe line trenches less than 12 ft. deep will most likely be excavated and backfilled before sheeting is required.
- Sheeting is only required when workers are in the trench and trench wall degradation is occurring.
- Workers will recognize sloughing and raveling: they will see it and feel it.

- Keep some plywood sheets on the job so that they are available when deterioration develops. Some reaches in your trench may be more susceptible to deterioration than others. Time and work flow will affect it.
- Plywood sheeting should have lift ropes or handles to allow proper moving, installation, and removal.
- Shores should be centered on the sheeting.
- Place the rails vertically in accordance with the tabulated data. Center them on the sheeting. There is no requirement to space the rails within a certain distance of the ends of the rails.
- Where the rails are longer than the sheeting or two separate sheets are required to reach the depth of the trench, the sheets may be required to be attached to the rails.
- Sheeting can be held up to 2 ft. maximum off the bottom of the trench, and can be gaped horizontally if it still prevents sloughing and raveling. For example, if the allowed rail spacing is 8 ft. on center with 4 ft. wide plywood, there would be a 4 ft. soil face between the sheeting. If raveling is still occurring at that point, close the gap until the raveling stops.

Decisions about attaching sheeting to the shore or using it separately:

If you are using sheeting, the question is whether you want the sheeting attached or separate. Here is a list of reasons or attributes associated with each configuration:

Plywood Attached

- Requires assembly at the shop
- Requires removal at the shop after use
- Shipping with plywood takes up much more space on the truck; it can double and triple the trucking costs as well as the loading time both ways
- Hydraulic shores with plywood attached should be set and removed with lifting equipment (backhoe or loader) due to weight and awkwardness; two sheets of 3/4 in. Finform weigh 160 lbs
- Plywood corners get broken or scraped off from being dragged over asphalt and dirt during resetting operations

Plywood Separate

- No assembly
- No removal
- Fork lift plywood stack onto truck, forklift bundled hydraulic shores onto truck; trucking costs are reduced.

- Up to 9 ft. long aluminum hydraulic shores can be handled, set, and removed by two workers without the assistance of lifting equipment.

No Plywood

- Lighter shores that can be handled with a 2-man crew
- Eliminates yarding maintenance and disposal costs
- Eliminates the environmental impact from logging and manufacturing plywood panels
- Eliminates pollution from lifting equipment and trucking

Something also needs to be said about the cost of installing plywood separately from setting the shores.

Conclusion:

After doing engineering, tabulation, training, and observation in the field related to aluminum hydraulic shores for over thirty years, two things stand out to me:

1. The use of sheeting with hydraulic shores is misunderstood and overapplied.
2. The construction industry is wasting far too much money, time, and valuable resources on the use of sheeting.

The fact that, in the United States, sheeting is used and applied differently on the East Coast and regions in between than it is on the West Coast with the same results in safety outcome attests to this. When I first thought this through, my concern was the safety of the attached sheeting method versus the unattached method. A study has not been conducted but my reasoning tells me that if there was a significant safety difference, it would have surfaced by now.

An “abundance of caution” has resulted in a huge cost for both methods; however, the attached method is far more costly than the unattached method. Unattached allows more selective use of sheeting and eliminates labor attachment costs and accident risks, extra shipping costs, and environmental impacts. Yarding, cleaning, inspecting, and inventorying are all impacted by attaching plywood to the shore. Think of a stack of plywood versus a fleet of winged trench jacks spread out in your yard and on your trucks. A study has not been conducted but it is easy to see that within our industry, from creation to supply to application, these costs amount to multimillions of dollars.

Through a singular and clear approach in training that clarifies the need for plywood sheeting on hydraulic shores, reduces the demand, and sets the standard application to shipping and applying sheeting separate from the shores, we can have a substantial, beneficial impact on safety and cost to our contractors who utilize vertical hydraulic shoring.

As part of the excavation shoring industry, it is our duty to not only develop new shoring system products but also to make sure that we are promoting the most efficient and cost-effective methods to contractors.

At this point, this concept is being floated to anyone within our industry who has an opinion on this. Please send comments to Joe Turner, (707) 484-4704, jmtengr2@aol.com.

FOOTNOTES:

[1] Do not just take my word for it! Karl Terzaghi, 1883-1963, one of the fathers of soil mechanics, discusses it in depth in **Soil Mechanics in Engineering Practice**, Third Edition, John Wiley and Sons, published 1996, Article 38 Arching in Soils.

[2] See my article **Excavation Systems Planning Design and Safety**, McGraw Hill, 2009, 6.4 Soil Arching Theory. The drawings included here are borrowed from that article.

[3] OSHA requires that the manufacturers of shoring equipment develop product information, tabulated data, and use handling and installation information. Only when that information is not available can the OSHA 1926 Subpart P Appendix D - Aluminum Hydraulic Shoring for Trenches be used. Technically, it can only be used for trenches and pits, and ancillary applications would require manufacturer's input or engineering.

[4] Contractors are aware that the concept of requiring that their Competent Person call all soil types OSHA C can be very costly. The abundance of caution is already present in Subpart P and doing it again at the contractor level can double and triple the cost without gaining anything on the safety side.

[5] The only reason Finform is listed in the OSHA standard is because the manufacturer of the product made it a point to be at the table when OSHA was formulating the standard. It had nothing to do with the strength of the product.