Construction Technology

Drilling and Excavating equipment & related Cost

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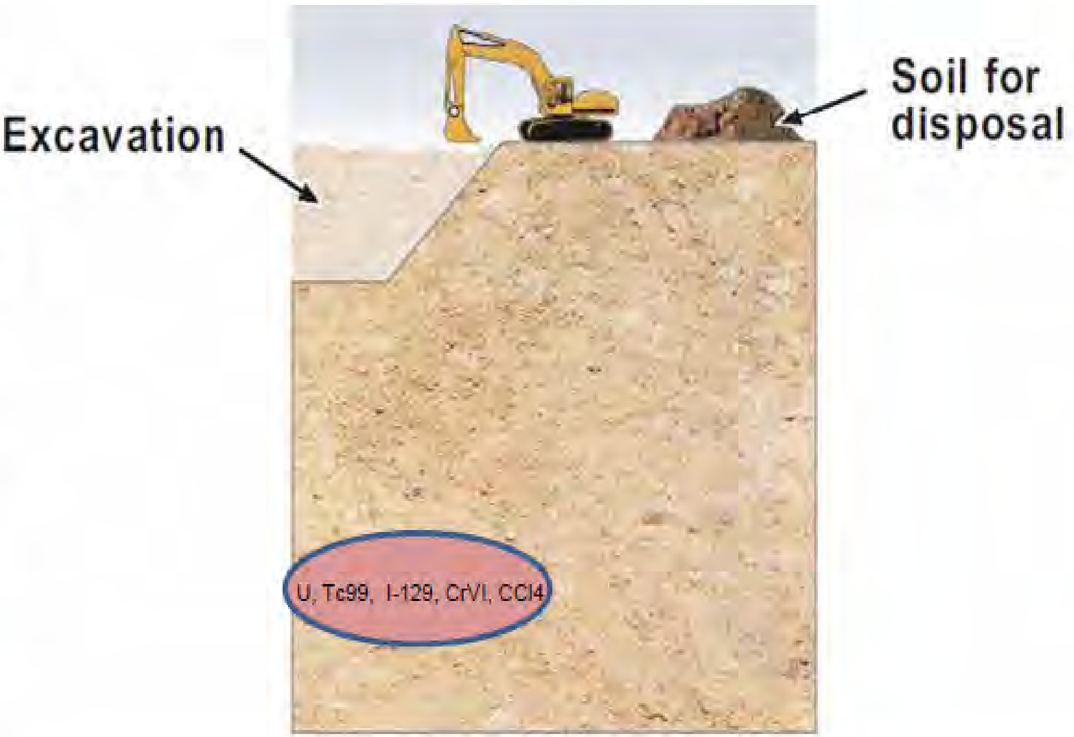
General Response Action – Removal, Excavation Methods

Potential Contaminants:
- All

General Description
- Excavation is advanced by using earthmoving equipment
- Overlying clean soil is removed and stockpiled
- Contaminated soil is removed and disposed
- Clean stockpiled soil is replaced to extent possible
- Excavation sides are sloped or supported
- Methods can be combined to achieve greater excavation depths



General Response Action - Removal, Excavation Methods

- Three primary methods for deep excavations:
  1. Open excavation using sloping or benching
  2. Drilling and soil replacement
  3. Excavation with braced sidewalls, such as
     a. Sheet pile walls
     b. Soldier piles wall
     c. Diaphragm walls
     d. Soil nail walls
     e. Cast pile wall
     f. Caisson wall
     g. Other misc methods

Technology - Deep Excavation with Sloping and/or Benching (Open Pit Mining)

Potential Contaminants:
- All

General Description

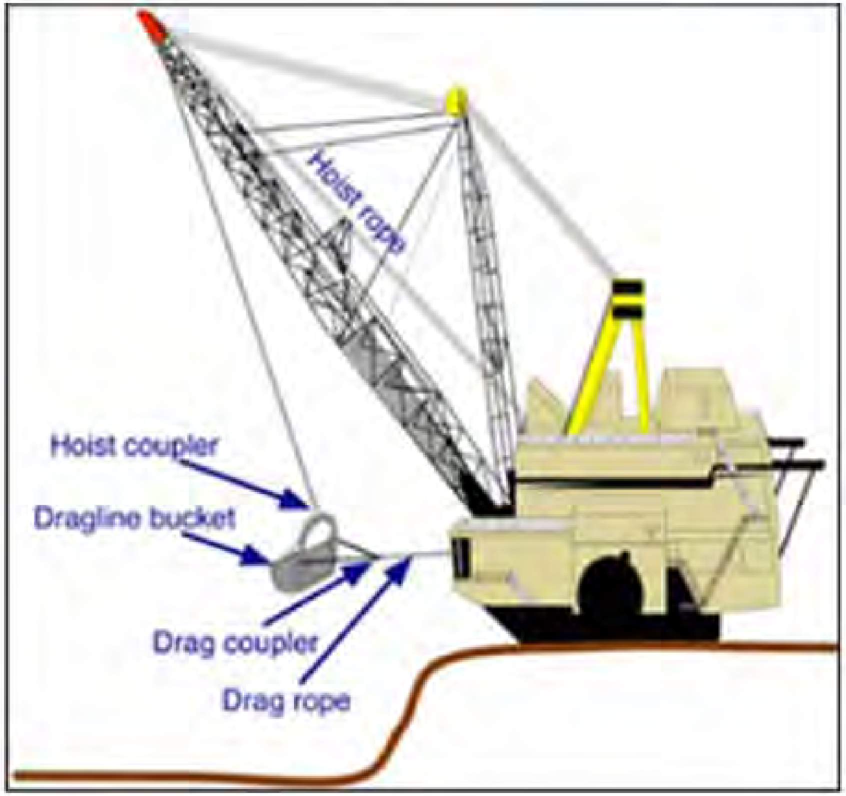
- Excavation is advanced by using earthmoving equipment
- Excavation sides are sloped or benched
- Can be combined with shoring to achieve greater excavation depths

Technology - Deep Excavation using Dragline Excavators

Potential Contaminants:
- All

General Description

- Excavation is advanced by using large draglines
- Walls are sloped or benched



Technology - Deep Excavation using Dragline Excavators

Limitations/Development Needs

- Sloped sides & dragline size may impact surface features
- Requires large stockpiles and separate disposal facility
- Cannot practically be combined with shoring
- Equipment availability

P&H Cranes/Harnishfeger Corp.

Technology - Deep Excavation using Drilling and Soil Replacement

Potential Contaminants:
- All

General Description

- Large diameter holes are drilled to remove contamination
- Each hole is backfilled with a low strength soil-cement mixture that does not require compaction

Bored-Piles.com

U.S. DEPARTMENT OF

Technology - Deep Excavation using Drilling and Soil Replacement

State of Development

- Mature - uses proven heavy equipment
- Large diameter borings have been drilled to over 200 feet at sites that included large cobbles

Limitations/Development Needs

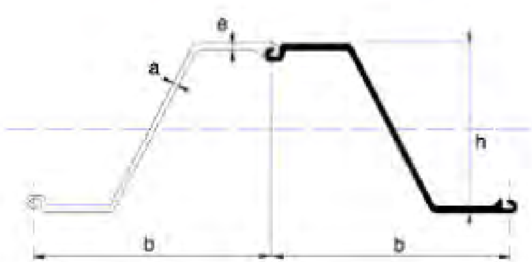
- Large equipment is required
- Large number of borings required to cover a large area or very accurate knowledge of contamination required
- Excavation control is more difficult with greater depth (e.g. achieving vertical borings)
- Requires re-excavation of some previously placed backfill if borings must overlap to remove entire target

Technology - Deep Excavation using Sheet Piling

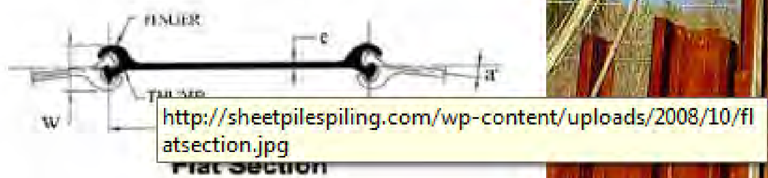
Potential Contaminants:
- All

General Description

- Steel sheet piling with interlocking grooves at the sides are inserted into soil by hammering or vibrating
- Excavation uses conventional equipment



Z Section



University of Syracuse, NY

Technology - Deep Excavation using Sheet Piling

State of Development

- Mature - uses proven equipment and materials
- Maximum depth is about 50 feet
- Walls can be supported or excavation can be stepped to achieve greater depths

Limitations/Development Needs

- Boulders and cobbles can prevent sheet pile insertion
- Wall support may be impractical at great depths

Dywidag Systems International/DSIAmerica

Technology - Deep Excavation using Soil Nail Walls

Potential Contaminants:
- All

General Description

- A shallow cut is made, and steel reinforcing bars are inserted into the cut face at regular intervals
- Wire mesh and sprayed-on concrete are applied to protect and support the face (other materials can be used)
- The process is repeated until target depth is reached

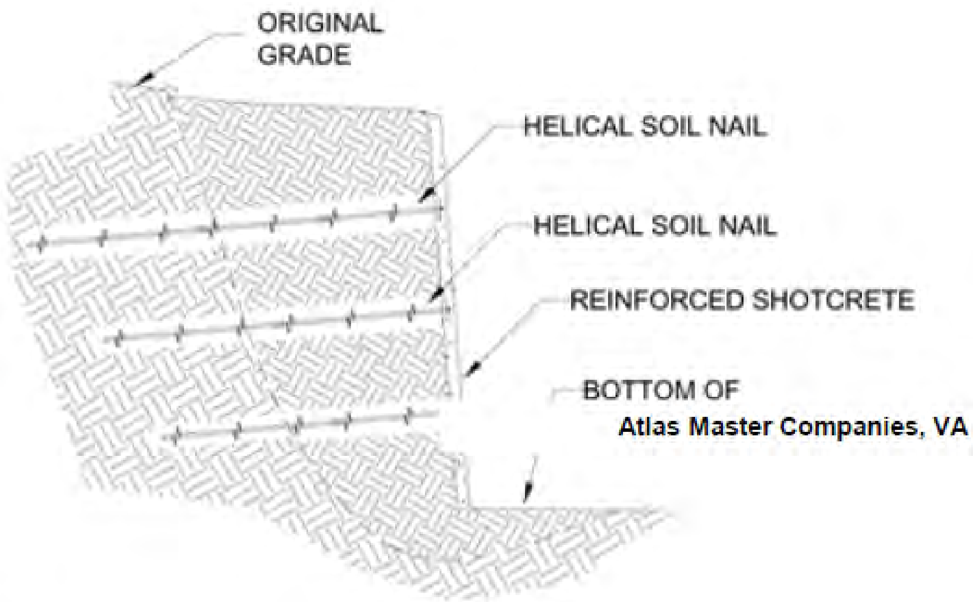


Figure 4

Technology - Deep Excavation using Soil Nail Walls

State of Development

- Mature - uses proven equipment
- Limited to about 30-40 feet
- Excavation can be stepped to achieve greater depths

Limitations/Development Needs

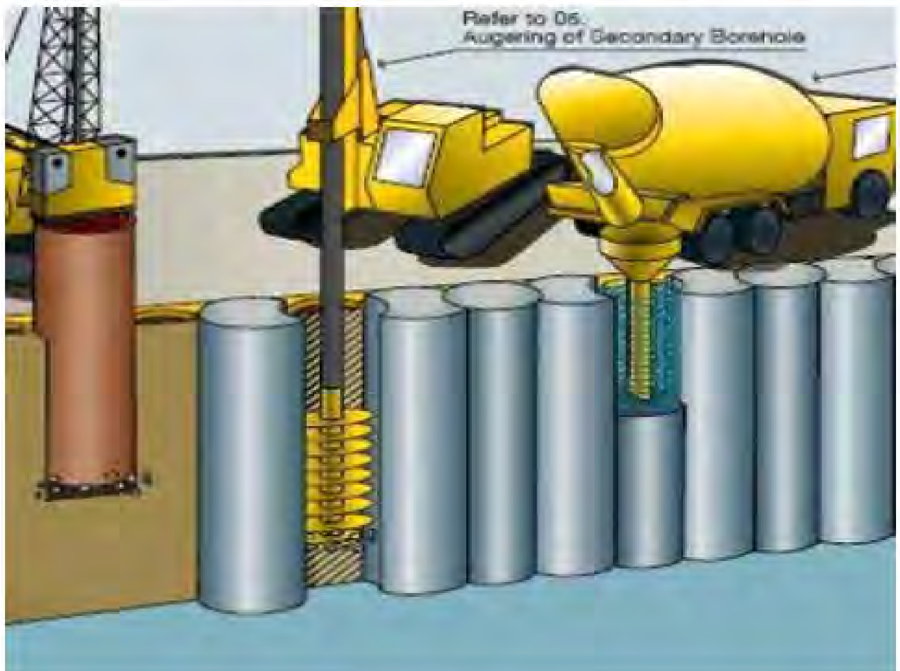
- Requires cohesive soil and unsaturated or minimal water flow conditions

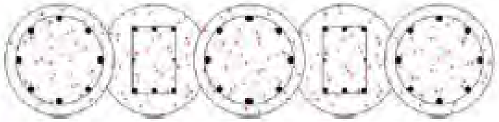
Technology - Deep Excavation using Secant Pile Wall

Potential Contaminants:
- All

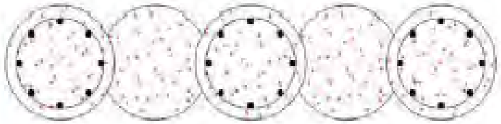
General Description

- Secant pile walls are formed by constructing intersecting drilled reinforced concrete piles
- Piles reinforced with steel reinforcing bars or H-piles





"Hard/Hard" Wall



"Hard/Soft" Wall

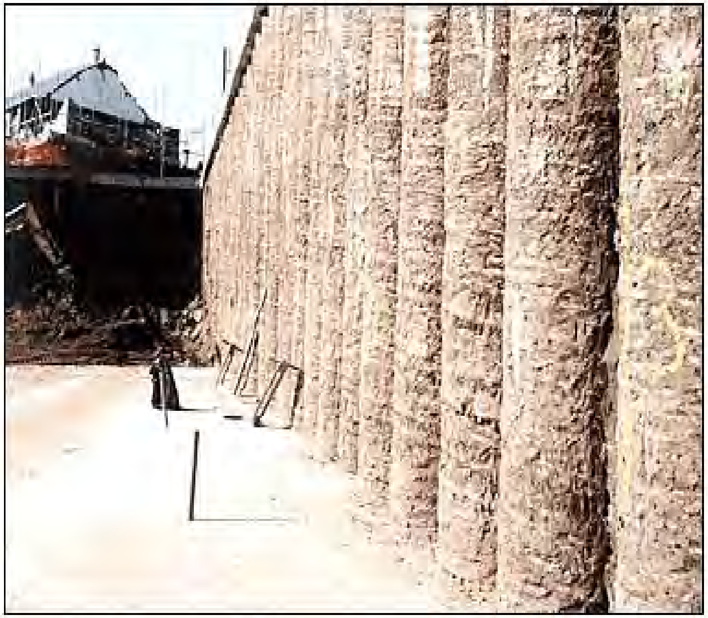
Technology - Deep Excavation using Secant Pile Wall

State of Development

- Mature - uses proven heavy equipment
- Maximum depth for single stage is about 50 feet; walls often anchored
- Excavation can be stepped to achieve greater depths

Limitations/Development Needs

- Vertical alignment control is critical and becomes more difficult with increasing depth and rocky ground



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Technology - Deep Excavation using Tangent Pile Wall

General Description

- Same as secant pile walls, except that piles touch but do not intersect

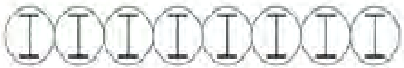
State of Development

- Mature - uses proven heavy equipment
- Maximum depth for single stage is about 50 feet; walls often anchored
- Excavation can be stepped to achieve greater depths

Limitations/Development Needs

- Vertical alignment control is critical and becomes more difficult with increasing depth and rocky ground
- More potential for gaps between piles than with secant pile wall

Potential Contaminants:
- All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Equipment Cost:

- ✓ From the construction standpoint, equipment cost rank second to labor cost in terms of the factors that affect the anticipated profit of the particular project.
- ✓ This course introduces the engineering fundamentals for planning, selection and utilization of Construction equipment.
- ✓ It enables us to analyze operation problems and to arrive at practical solutions for completing construction tasks.
- ✓ It is about the application of the engineering fundamentals and analysis to construction activities and economic comparison of the equipment choices.
- ✓ The construction contractor ability to win a contract and perform them at a profit is determined by two vital assets: People and equipment.
- ✓ For the equipment to be economically competitive, the contractor equipment must be competitive both mechanically and technologically . Old machines which require costly repair can not compete successfully with new equipment having lower repair costs and higher production rates.
- ✓ The accurate estimation of the equipment cost is very important to the success of the Contractor.
- ✓ **There are three means by which the equipment may be employed on a project:**

1- Machines may be purchased:

- **Machines may be purchased** by the contractor and become part of his equipment fleet.
- This provides the least hourly cost charge.
- The risk increases because the ownership cost increases whether the machine is used or not.
- Owning equipment involve major investment, therefore the equipment must pay for itself and must be selected properly.
- In small projects, purchasing equipment is not recommended.

2- Machines may be Leased:

- This usually results in a higher hourly cost compared with owning equipment.
- For example you may lease the equipment for certain period not for days or hours.
- But the risk decreases because you have to utilize this equipment only for the duration of the lease.
- Risk is less while hourly cost is high.
- It is suitable when the equipment is needed for a short duration, and its purchase cost is high.

3- Machines may be Rented:

- This usually provides the highest hourly charge, but these expenses are justified because of the relatively short duration of time. The risk is the minimum in this case.

- For example you may rent the equipment for a day or few hors upon the equipment need.

- Risk is the least while hourly cost is highest.

Equipment Type:

- **Standard type:** generally applies to equipment which are commonly manufactured and available to all purchasers. Spare parts are readily available. This type of equipment serves many purposes.

- **Special Type**: generally applies to equipment which have to be manufactured for specific projects. Example, tunnel boring machines, large hauling units and very large shovels. Spare parts are not readily available but it custom made.

Ownership Cost

Elements of Ownership cost:

- Purchase Expenses. The money spent in purchasing the equipment, including shipping, delivery to site, sales taxes and custom duties.
- Salvage Value, the selling price of the equipment after is disposal.
- Property Taxes, money charged by the government for the equipment Ownership.
- Major Repair and overhauls
- Insurance, money paid to cover fire, theft and damage that may occur to the equipment.
- Storage and miscellanies

Elements of Operating cost:

Operating cost is the sum of expenses the owner pays by working a machines. Typical expenses includes:

- ✓ Fuel
- ✓ Lubricants, Filters and grease.
- ✓ Repairs, tires.
- ✓ Replacement of high wear items.

- A great amount of money is tied up in the purchase of the equipment, if money is borrowed from the bank, the interest rate increases with time. This is part of the ownership cost.

- Equipment loses its value (it depreciate) and usually sold for a less value than its purchase cost.

How to estimate the Ownership Cost?

- Estimate the purchase price of the equipment, then estimate the possible useful life and probable salvage value if its sold at the end of its useful life (based on the historical records of manufacturer's information).
- Select an appropriate interest rate for money. Most company take the bank interest rate and add a factor to account for, the risk involved in purchasing the equipment, and then Estimate the minimum average rate of return (MARR).
- **Estimate the average cost associated with taxes, insurance and storage each year and convert these cost into an equivalent interest rate based on the value of equipment at any time.**
- **Add the MARR and the interest rate in 3 and use the time value of money to estimate the uniform annual Ownership cost.**

Time Value of Money

- One dollar today is more than one dollar tomorrow
- If interest rate is 14% this means that one 1000 dollar today equal 1140 dollar next year
- **F** is the future amount of money after n years,
- **P** is present value of Money,
- **I** = interest rate.

- At end of first year F1 = P+Pi
- At second year F2 = P + Pi +(P+Pi) x i= $P(1+i)^2$
- At N number of year FN = P + Pi +(P+Pi) x I + ..= $P(1+i)^n$

Time Value of Money

- A contractor wishes to deposit an amount of money in the bank to buy a piece of equipment with 120,000$. The bank interest rate is 14%/ year, how much money that should be deposited in the bank now in order for the contractor to be able to buy such piece of equipment after 6 years.

$F = P(1+i)^n$

- $120{,}000 = P\,(1+0.14)^6$
- P= 54670 $

Ownership Cost:

- **Example:** Apiece of Equipment is estimated to cost \$67,000 new and to have a useful life of 7 years with a salvage value of \$7,000. The Company believe that the MARR would be 12%. Taxes, insurance and storage should amount to an additional 8%. Estimate the uniform annual ownership cost.

- P= \$67,000
- F= \$7,000.
- Useful Life= 7 Years
- MARR = 12%.
- Additional Services= 8%
- Total Interest Rate= 12+8 = 20%

Ownership Cost:

The annual cost of the equipment is (A)

- **$A = P[i * (1+i)^n]/[(1+i)^n-1] - F\ (i)/(1+i)^n-1$**
- EQ 1.6 EQ. 1.4
- **$A=67000[0.2*1.2^7]/[(1.2)^7-1] – 7000 *0.2/[(1.2)^7-1] =$**
- **67000 *[(0.2*3.5831)/(2.5831)- 7000 * 0.20/2.5831=**
- **18585.8 - 541.985 = $18045**
- **If we are working 5 days a week then we will work 260 days.**
- **Daily Cost= 18045/260=$69.40 per day**
- **If we work 8 hours per day, then the hourly cost =**
- **69.4/8 = $8.675 per hour.**

Ownership Cost:

- **Example:** A machine cost $45,000.00 to purchase. Fuel, oil, Grease (FOG) and minor maintenance are estimated to cost $12.34 per operating hours (those hours when the engine is operating and the machine is doing work).
- A set of tires cost $3,200.00 to replace, and their estimated life time is 2800 use hours. A $6,000.00 major repair will probably be required after 4200 hours of use. The machine is expected to last for 8,400 hours after which it will be sold at a price (salvage value) equal 10% of the original purchase price. A final set of new tires will not be purchased before the equipment sale.
- How should the owner of the machine charge per hour of use, if it is expected that the machine will operate 1,400 hours per year and the company's cost of the capital rate is 7%. Company profit is estimated to be 12%.

Ownership Cost:

- P =$45,000 F = 0.1 x 45,000 = $4,500
- I = 7 + 12 =19%
- No. of years = 8400/1400 = 6 years.
- A= P[i * $(1+i)^n$]/[$(1+i)^n$-1]- F (i)/$(1+i)^n$-1
- A= 45,000 * {0.19 * (1.19)6 /[1.19)6-1]} – 4,500 * 0.19/[1.19)6-1]
- A= 45,000 * 0.539555/1.839761 - 4,500 * 0.19/1.839761
- A= 13197.34 - 464.7343 = $12732.61/year
- Hourly cost =12732.61/1400= $9.094721/Hr.

Additional Cost:

- 1. Fuel, Oil & Grease and minor Maintenance = $12.34 Hr.
- 2. Hourly cost of Tires = 3200/2800 = $1.142857
- 3. Hourly cost of Major repair = 6000/4200 = $1.428571
- The total hourly cost = 9.095+ 12.34 + 1.143 + 1.429 = $24.007/Hr.

ممكن تقول لي ما هو وجه الصعوبة في هذه المسالة

Depreciation:

- **Depreciation: it is the loss in the value of the piece of equipment over time generally due to wear and tear from use, deterioration, obsolescence or reduced needs.**

- **Depreciation rate is equal to the purchase value of the piece of equipment divided by the number of years of useful life of equipment.**
- **For 5 years of useful life, Depreciation rate = 20%**
- **For 8 years of useful life, Depreciation rate = 12.5%**

Next lecture, Contracts

THANK YOU!