

Lesson 4

Construction Techniques and Materials

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Learning Outcomes

- Describe sequence of construction for a micropile
- Identify materials used to construct a micropile
- Describe principle function of these materials
- Describe key elements to good grouting



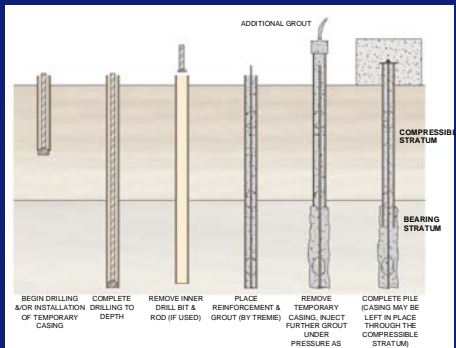
Basic Construction

Sequence Involves

- Drilling
- Placing reinforcement
- Grouting



Typical Micropile Construction Sequence with Casing



Drilling Method: Principles of Selection

The method selected must:

- Provide a stable hole of the required dimensions and within stated tolerances
- Be compatible with project access and environmental constraints, e.g., noise and vibration thresholds
- Allow completion of each hole within a single day
- Be compatible with spoils handling requirements
- Consider presence of hazardous materials

Drilling Method: Principles of Selection

The method selected must:

- Be capable of drilling in all soil and rock conditions
- Be able to drill subhorizontal, vertical, and inclined holes
- Be able to drill beneath the water table
- Not impart damage to ground or existing foundations
- Be able to be controlled and monitored

Traditional Rigs



Excavator-Mounted Drilling Mast



Purpose-Built Low Headroom Drill Rig

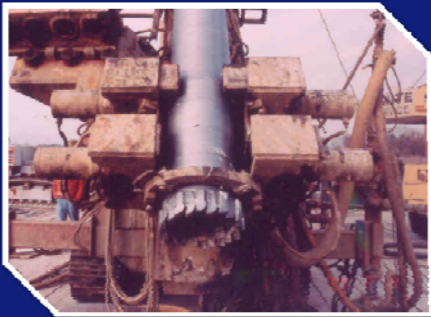


Typical Overburden Cased Drilling Techniques

- Single-tube advancement
 - external flush (wash boring)
 - drive drilling (lost point)
- Rotary duplex
- Rotary percussive duplex (concentric)
- Rotary percussive duplex (eccentric)
- Double head duplex
- Hollow stem auger
- Sonic



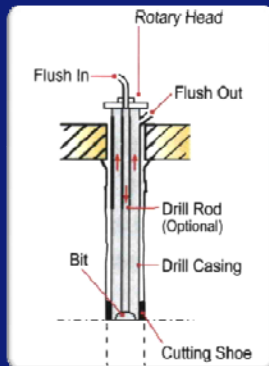
Single Tube End of Casing Flush



Rotary Duplex Rod and Casing



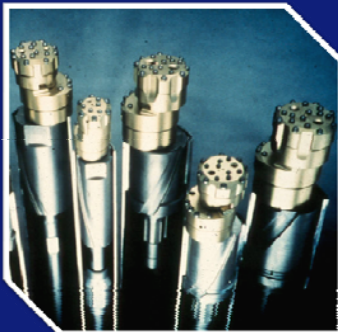
Duplex Drilling



Rotary Percussive Concentric Duplex

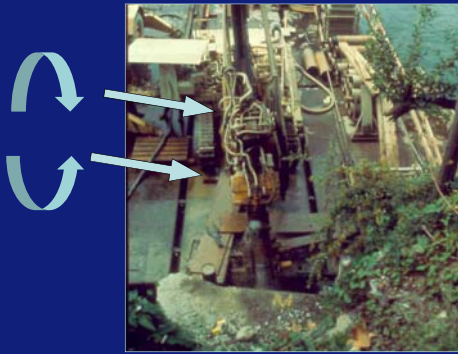


Rotary Eccentric Percussive Duplex Drilling



This one is called Tubex

Double Head Duplex



Hollow Stem Auger



Sonic Drilling Rig



Courtesy: Boart Longyear

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Overburden Drilling Methods (FHWA, 1997)

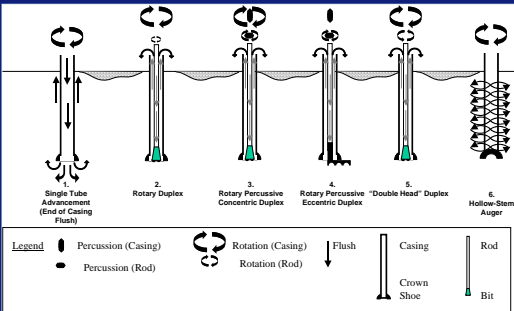


Figure 4-9

High Speed, Low Torque Drilling



Low Speed, High Torque Drilling



Rotary Percussive Drilling (Down-the-Hole Hammer)



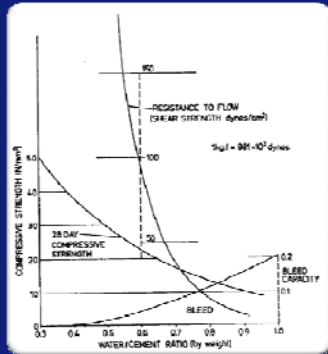
Grouting and Grout Function

- Transfers loads from reinforcement to surrounding ground
- May be load-bearing portion of pile
- Protects steel reinforcement from corrosion
- May be used as drill fluid during initial drilling
- Secondary/Post grout enhances soil/grout bond further

Typical Grouting Characteristics

- Neat cement grouts with water/cement ratios of 0.40 to 0.50
- Potable water used to reduce corrosion potential
- Type I/II cement (ASTM C150/AASHTO M85), in bag or bulk form
- Additives to improve pumpability in special cases
- Compressive strengths of 28 to 35 MPa (4 to 5 ksi)

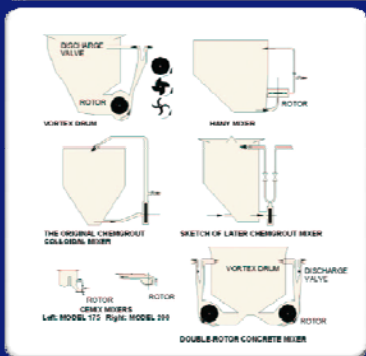
Design Guidelines: Neat Cement Grout



Grouting Equipment

- Mixers
 - High-speed, high-shear colloidal mixers recommended
 - Low-speed, low-energy mixers (paddle mixers) are occasionally still used
- Pumps
 - Constant pressure, rotary-screw type pumps (Moyno)
 - Fluctuating pressure piston or ram pumps
- Agitation Tanks
- Combined Units
- Batching and Injection Monitoring Equipment (i.e., QA/QC)

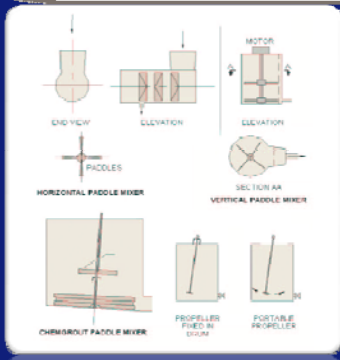
Principles of High Speed High Shear Mixers



Typical Mobile Mixer/Pump Unit



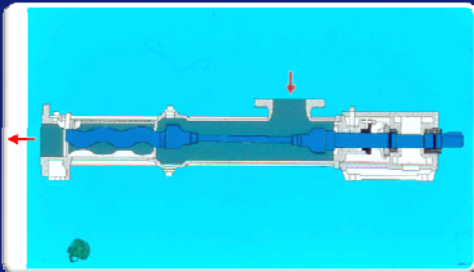
Various Types of Paddle Mixers/Agitators



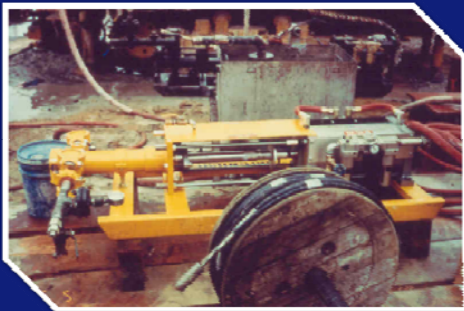
Pumps

- Moyno Pump (Primary grouting) – high volume, low pressure
 - [50 gpm at up to 300 psi]
- Piston Pump (Secondary, post grouting) – low volume, high pressure
 - [15 gpm at up to 1200 psi]

Diagram of Progressive Cavity Pump



Piston Pump as used in Post Grouting



Contemporary Bulk-fed
Grouting Module



Keys to Good Grouting

- Grout Batching
- Water added to mixer using calibrated tank or flowmeter
- Cement is batched by weight, either in bags or bulk from a silo
- Additives are usually proportioned in relation to weight of cement



Keys to Good Grouting

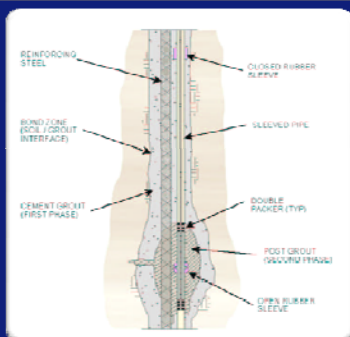
Grout Mixing

- Grout mixing sequence: water, cement, additives
- Grout colloiddally (high shear) mixed for a maximum of 2 minutes and then held in a paddle agitation tank until needed
- Safe workability time typically not in excess of 1 hour

Grout Monitoring



Principle of Tube à Manchette Method Postgrouting (i.e., Type D)



Structural Steel

Types

- Reinforcing steel bars (rebar)
- Continuous-thread solid steel bars
- Continuous-thread hollow-core steel bars (injection bore)
- Steel pipe casing
- Composite reinforcement



Materials - Steel



Courtesy: Cortech Systems



Close up of Bit on Injection-bore Threaded Bar



Reinforcing Core Steel

- Placed either before or after initial tremie grouting (but always before the temporary casing is withdrawn)
- Reinforcement must be clean of surface soil and mud
- Centralizers used to maintain the specified grout cover



Casing/Pipe

- Typical
 - Mill Secondary Oil Field Casing
 - Flush threaded joints
 - 80 ksi min Yield Strength



Casing

CONSTRUCTION: STEEL CASING; THREADED SINGLE CASING

Steel Iron Works manufactures single or machine casing with flush tapered threads designed for the best available



Multiple wall thickness available

THREADED SINGLE CASING	O.D.	WALL	O.D.	WALL
2 1/8	280.325	7	362.596	
3 1/2	368.320	7 5/8	420.300	
4	330.320	8 5/8	502	
4 1/8	430.321	9 5/8	545	
5	368.320	10 5/4	520-545	
5 1/2	568.325	11 5/4	545	
6 5/8	740.325	12 5/4	565	

24, 32, 36 and 48 inch outside diameters available



Grooved Oversized Hole in Existing Foundation



Composite Reinforcement



Courtesy: Hayward
Baker



Learning Outcomes

- Describe a few key drilling methods
- Identify materials used to construct a micropile
- Describe principle function of these materials
- Describe key elements to good grouting





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Questions & Discussion

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