Subsurface Drilling and Sampling

Course Number: GE-02-601

PDH: 4

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Module 3: Drilling and Sampling of Soil and Rock

Learning Objectives

By the end of this section, you will be able to:

- **Select** the appropriate drilling and sampling methods based on specific soil, rock, and groundwater conditions.
- **Identify** and **mitigate** common drilling errors, such as improper borehole stabilization or inadequate slough removal, to ensure sample integrity.
- **Evaluate** rock mass quality by calculating Rock Quality Designation (RQD) and assessing core recovery and soundness.

Executive Summary: Successful subsurface exploration relies on selecting equipment compatible with the site's geology and maintaining borehole stability, especially below the groundwater table, to retrieve representative samples for examination and testing.

Soil Exploration

Soil Drilling

A wide variety of equipment is available for performing borings and obtaining soil samples. The method used to advance the boring must be compatible with the soil and groundwater conditions to ensure sample quality.

Solid Stem Continuous Flight Augers

- **Application**: Generally limited to stiff cohesive soils where boring walls are stable for the entire depth.
- **Operation**: A drill bit is attached to the leading flight, and the flights act as a screw conveyor to bring cuttings to the surface.
- **Limitation**: Due to their limited application, they are generally not suitable for investigations requiring soil sampling.
- **Optimization**: Use "dead-stick withdrawal" (withdrawing without rotation) to maintain cuttings on flights with minimum mixing for better visual identification.

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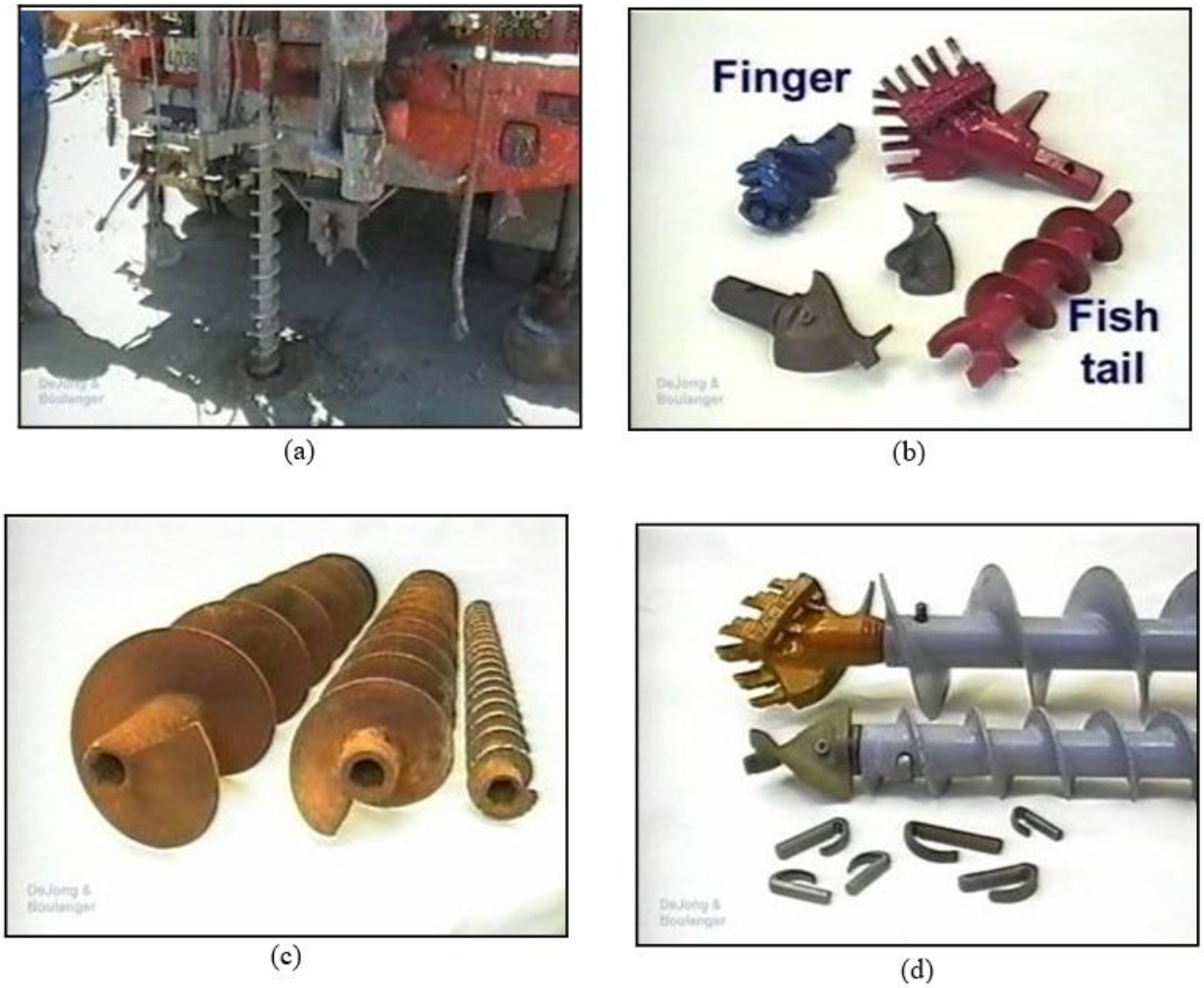

Figure 3-1. Solid Stem Continuous Flight Auger Drilling System: (a) In use on drill rig, (b) Finger and fishtail bits, (c) Sizes of solid stem auger flights, (d) Different assemblies of bits and auger flights. (All pictures in the above format are courtesy of DeJong and Boulanger, 2000)

Hollow Stem Continuous Flight Augers

- **Advantage**: The hollow center allows for a center stem and plug to be inserted during advancement, which prevents soil from entering the auger.
- **Application**: Commonly used in clay soils or granular soils above the groundwater level where walls may be unstable.
- **Stabilization**: The augers form a temporary casing to allow sampling of undisturbed soil below the bit.

💡 **Design Tip**: Never advance the boring without the center plug to allow a natural "plug" of cuttings to form; the extent of such a plug is difficult to control and determine.

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Table 3-1. Dimensions of Common Hollow-Stem Augers

Inside Diameter of Hollow Stem mm (in)	Outside Diameter of Flighting mm (in)	Cutting Diameter of Auger Head mm (in)
57 (2.250)	143 (5.625)	159 (6.250)
70 (2.750)	156 (6.125)	171 (6.750)
83 (3.250)	168 (6.625)	184 (7.250)
95 (3.750)	181 (7.125)	197 (7.750)
108 (4.250)	194 (7.625)	210 (8.250)
159 (6.250)	244 (9.625)	260 (10.250)
184 (7.250)	295 (11.250)	318 (12.000)
210 (8.250)	311 (12.250)	330 (13.000)
260 (10.250)	356 (14.000)	375 (14.750)
311 (12.250)	446 (17.500)	470 (18.500)

Note: Adapted after Central Mine Equipment Company. For updates, see: http://www.cmeco.com/

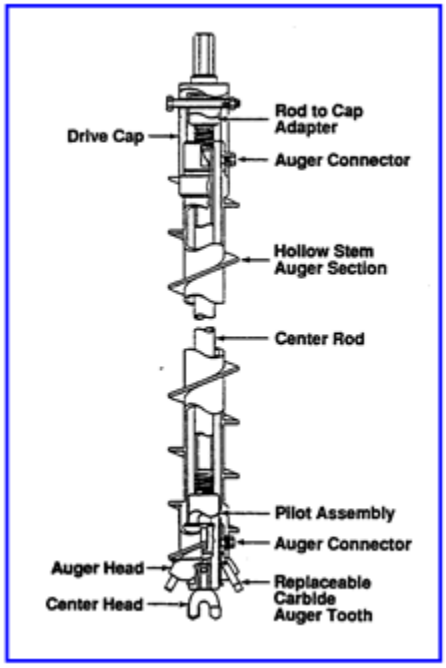

Figure 3-2. Hollow Stem Auger Components (ASTM D 4700).

Figure 3-3. Hollow Stem Continuous Flight Auger Drilling Systems: (a) Comparison with solid stem auger; (b) Typical drilling configuration; (c) Sizes of hollow stem auger flights; (d) Stepwise center bit; (e) Outer bits; (f) Outer and inner assembly.

Rotary Wash Borings

- **Application**: Generally the most appropriate method for soil formations below the groundwater level.
- **Stabilization**: Borings are supported by casing or drilling fluids like bentonite or polymers.
- **Maintenance**: Maintain a head of water/fluid within the casing above the groundwater level to prevent soil loosening or heaving (blow-up).

⚠️ **Safety Constraint**: When using drilling fluids, maintain the fluid level at or above the ground surface to ensure positive pressure throughout the boring's full depth.

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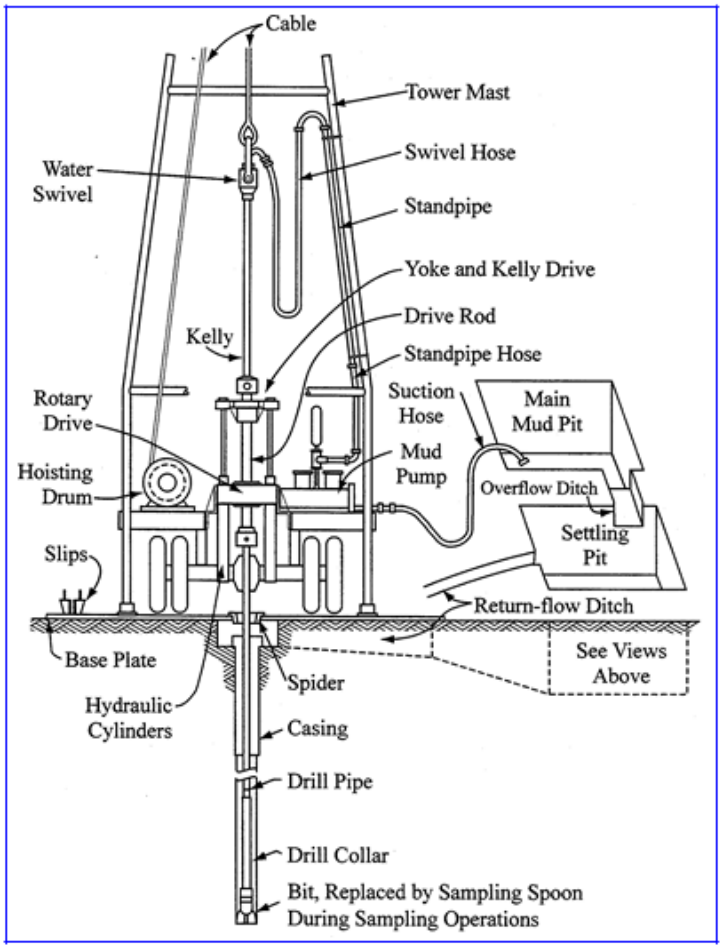

Figure 3-4. Schematic of Drilling Rig for Rotary Wash Methods (After Hvorslev, 1948).

Table 3-2. Dimensions of Common Drill Rods

Size	Outside Diameter of Rod mm (in)	Inside Diameter of Rod mm (in)	Inside Diameter of Coupling mm (in)
RW	27.8 (1.095)	18.3 (0.720)	10.3 (0.405)
EW	34.9 (1.375)	22.2 (0.875)	12.7 (0.500)
AW	44.4 (1.750)	31.0 (1.250)	15.9 (0.625)
BW	54.0 (2.125)	44.5 (1.750)	19.0 (0.750)
NW	66.7 (2.625)	57.2 (2.250)	34.9 (1.375)

Note 1: "W" and "X" type rods are the most common types of drill rod and require a separate coupling to connect rods in series. Other types of rods have been developed for wireline sampling ("WL") and other specific applications.
Note 2: Adapted after Boart Longyear Company and Christensen Dia-Min Tools, Inc. For updates, see: http://www.boartlongyear.com/

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