

CECW-EG Engineer Regulation 1110-1-1807	Department of the Army U.S. Army Corps of Engineers Washington, DC 20314-1000	ER 1110-1-1807 30 Sep 1997
	Engineering and Design PROCEDURES FOR DRILLING IN EARTH EMBANKMENTS	
	Distribution Restriction Statement Approved for public release; distribution is unlimited.	

CECW-EG

Regulation
No. 1110-1-1807

30 September 1997

Engineering and Design
PROCEDURES FOR DRILLING IN EARTH EMBANKMENTS

1. Purpose.

This regulation establishes policy and requirements and provides guidance for drilling in dam and levee earth embankments and/or their earth foundations.

2. Applicability.

This regulation applies to all major subordinate commands (MSC), district commands, laboratories and field operating activities having Civil Works and/or Military Program responsibilities. It applies to in-house and contracted efforts.

3. References.

- a. EM 1110-1-1804 Geotechnical Investigations.
- b. EM 1110-1-1906 Soil Sampling.
- c. EM 1110-2-3506 Grouting Technology.
- d. CWGS-02010 Subsurface Drilling, Sampling, and Testing.
- e. ASTM D 1452 (1980; R 1990) Soil Investigation and Sampling by Auger Borings.

f. ASTM D 1586 (1984; R 1992) Penetration Test and Split-Barrel Sampling for Soils.

4. Distribution.

This regulation is approved for public release; distribution is unlimited.

5. Background.

In the past, compressed air and various drilling fluids have been used as circulating media while drilling through earth embankments and their foundations. Although these methods have been used successfully in accomplishing the intended purposes, there have been many incidents of damage to embankments and foundations. While using air (including air with foam), there have been reports of loss of circulation with pneumatic fracturing of the embankment as evidenced by connections to other borings and blowouts on embankment slopes. While using water as the circulating medium, there have been similar reports of erosion and/or hydraulic fracturing of the embankment or foundation materials.

6. Policy.

- a. This regulation provides guidance

for drilling in earth embankments and their soil and soft rock foundations. It identifies acceptable and prohibits unacceptable techniques and circulating media and prescribes personnel requirements and approved drilling methods.

b. Personnel involved in drilling into or through dam and levee earth embankments shall be senior, well qualified, and experienced in the processes and procedures outlined within this regulation. Designs shall be prepared and approved by geotechnical engineers and/or engineering geologists. Drillers and mud engineers shall be industry specialists and experts in their fields.

c. Drilling in embankments or their foundations using compressed air (including air with foam) or any other gas or water as the circulating medium is prohibited. This prohibition shall apply whether drilling is done with hired labor or with contract drilling. Further, it will apply regardless of the purpose of drilling, whether for investigations, grouting, instrumentation installation, or any other reason.

d. Auger drilling is the recommended method for advancing a hole through an earthen embankment. If auger tools are used, either bucket, continuous flight, or hollow stem augers shall be used, and under no circumstances shall drill fluid circulation be used. Hollow stem augers may be used with Standard Penetration Test equipment.

e. Cable tool (churn) drilling and rotary drilling may also be used when auger

drilling is impracticable. If the cable tool method is used, drilling tools shall be restricted to hollow sampling (drive) barrels in earth embankment and overburden materials. If rotary drilling is used, an engineered drilling fluid (or mud) shall be used. If rotary drilling with fluid is selected as the drilling method, procedures detailed in Appendix A shall be used.

f. Exemptions to or deviations from these prohibitions and requirements may be made only in special circumstances and when all other acceptable alternatives have been exhausted. Drilling through pervious rockfill or gravel sections of an embankment or foundation could be considered an appropriate instance for exemption. Granting of an exemption should not be taken lightly since inappropriate drilling has caused serious dam safety consequences. It is the responsibility of the District Dam Safety Officer (DSO) to assure compliance with the restrictions and procedures outlined in this regulation. Written requests for waivers to this regulation must be submitted for approval to the DSO before beginning the work. This request shall include details of the design, drilling personnel, equipment and procedures to be used, as well as detailed descriptions and cross sections of the embankment and the foundation materials to be penetrated. The DSO shall assure that documentation for each waiver request receives an independent technical review prior to his decision to grant or reject the request. Finally, the DSO shall notify CECW-EG prior to granting any exemption or deviation from these requirements.

FOR THE COMMANDER:

1 Appendix
APP A - Rotary Drilling Procedures for
Earth Embankments

A handwritten signature in cursive script that reads "Otis Williams".

OTIS WILLIAMS
Colonel, Corps of Engineers
Chief of Staff

APPENDIX A
ROTARY DRILLING PROCEDURES FOR EARTH EMBANKMENTS

A-1. Purpose.

This appendix prescribes materials and procedures to be followed when using rotary drilling equipment and methods for sampling and/or advancing a drill hole through an embankment to set casing.

A-2. Procedure.

Holes into or through an embankment shall be drilled with a noncoring type roller (preferred), fishtail or other suitable bit as necessary to drill a minimum 140 mm (5-1/2 inches) diameter hole in the embankment and overburden. Where practicable, openings or nozzles directing flow of the circulation fluid should be upward or side discharge. A commercial drilling mud shall be used as the drilling fluid. The mud shall have sufficient consistency and weight to prevent caving and minimize intrusion of the drilling mud into the embankment and overburden. Thorough washing out and removal of all cuttings during drilling is essential.

Upon reaching foundation rock, an NW size, 88.9 mm (3-1/2 inches) O.D. x 76.2 mm (3 inches) I.D., flush-joint casing shall be inserted in the hole and firmly seated in rock. After seating the casing, drilling mud shall be flushed from inside the casing. However, mud shall be maintained outside the casing until it is removed from the hole after backfilling. Every effort shall be made to avoid loss of circulation and embankment

damage. This shall include careful control of the following:

a. Excess drill penetration rate or down pressure may cause embankment damage. What constitutes “normal” and “excessive” drilling parameters can be expected to vary considerably from embankment to embankment and from hole to hole. Normal drilling parameters should be established during initial drilling of an embankment in a relatively clean hole.

b. A drilling rate of not more than 1.5 meters (5 ft) penetration in five minutes should be maintained when drilling in clay. To prevent damage from clay buildup on the drill rods or balling of the bit and overloading (clogging) the annulus of the hole, the drill stem should be slowly raised and cleaned if clay buildup occurs.

c. Surges in pumping rate or pressure should be avoided. Pump pressure and drill down-pressure readings must be continually monitored. If the pump pressure increases by 50 percent during the drilling of any 1.5 meter (5 ft) increment, the bit should be picked up slowly and the hole allowed to clean.

d. Attempt to drill through any tight sections. Do not advance the hole by rapid raising and lowering of the drill tools. Raise or lower drill tools slowly to prevent pressure changes that cause caving.

30 Sep 97

e. Run the pump for 15 seconds with the bit on the bottom of the hole before adding a joint of drill rod.

f. Operate the pump at the lowest rate that will assure adequate cooling and cleaning of the bit and removal of cuttings.

A-3. Drilling Fluid Mix.

The initial drilling fluid mix shall be as follows, using materials similar or equal to the Baroid products listed:

a. To 378.5 liters (100 gallons) of water add:

9 kg (20 lbs., one-half sack)

HYSEAL

11.3 kg (25 lbs., one-half sack)

MICATEX

4.5 kg (10 lbs., one-fifth sack)

QUIKGEL

2.3 kg (5 lbs., one-quarter sack)

JELFLAKE

0.47 liters (1 pint) CONDET

b. If severe loss of drilling fluid occurs, double the amounts of HYSEAL, MICATEX, and JELFLAKE. A mixing tub or holding tank large enough to hold an adequate quantity (at least 1.5 times the hole volume) of drilling fluid mix should be maintained on site. This will insure that the hole is filled with drilling fluid and kept open at all times.

c. The maximum allowable mud weight is 1153 kg/m³ (72 lbs/ft³). Drilling mud viscosity also should be monitored continually using a Marsh funnel and should

be maintained within 60 to 70 seconds. Drilling mud should be weighed every 15 minutes, adding water or new mix while drilling to maintain minimum weight (hydrostatic head and solids content), viscosity (pressure in the annulus while circulating) and filtration (filter cake restriction of the annulus). When drilling mud weight reaches 1153 kg/m³ (72 lbs/ft³), stop drilling and pumping and mix a new batch of drilling mud.

d. Adjustments should be made to this initial mix during the drilling operation if problems or unfavorable results occur such as clay buildup. If significant loss of drilling fluid or other problems continue, the use of rotary drilling shall be discontinued and a new tactic developed in consultation with the DSO and CECW-EG.

A-4. Backfilling Holes.

After the rock section of the hole has been grouted to refusal, the casing should be pulled to approximately one meter (3 ft) above top of rock. The grout injection pipe should then be pulled to near top of rock. Backfilling of holes in overburden and/or an earthen embankment shall be accomplished by injection of grout through a tremie pipe or hose inserted to a depth below top of rock. The backfill or grout mix should be changed to an appropriate mix that approximates the properties of the undisturbed embankment. The hole should then be backfilled (grouted) to a level not to exceed approximately 15 meters (50 ft) above the casing bottom. The estimated quantity for backfill grout shall always be calculated before starting

backfilling operations, and injection quantities shall be monitored continuously. If the estimated quantity per 0.3 meters (one ft) of hole is exceeded by a meaningful amount at any time, operations shall be halted. The casing should then be pulled to the top of the grout and the backfill allowed to set. Prescribed backfilling operations can then resume. The casing should then be slowly pulled a maximum of 4.5 meters (approximately 15 ft) above top of rock, the injection pipe pulled approximately 1.5 meters (5 ft) above top of rock, and the hole again grouted to a level not to exceed 15 meters (50 ft) above casing bottom.

The injection pipe and casing should then be

withdrawn in increments not to exceed approximately 15 m (50 feet), keeping the hole filled with the backfill mix to a level not to exceed approximately 15 m (50 feet) above casing bottom at all times. After the casing has been removed, the hole should be periodically checked for a period of 24 hours and kept full of backfill mix until the material has set.

Backfilling of holes in an embankment in which an instrument has been installed will be in accordance with prescribed procedures for that instrument, but will follow techniques and requirements as described above when practicable.