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SONIC DRILLING ON EMBANKMENT DAMS AND LEVEES

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SONIC DRILLING

- Guidelines for Drilling In and Near Embankment Dams and Their Foundations (FERC, Jun 2016)
- Guidelines for Drilling and Sampling in Embankment Dams (USBR, Apr 2014)
- ER 1110-1-1807 Drilling in Earth Embankments and Levees (USACE, Dec 2014)

SONIC DRILLING

DRILLING WITH SONIC TECHNOLOGY

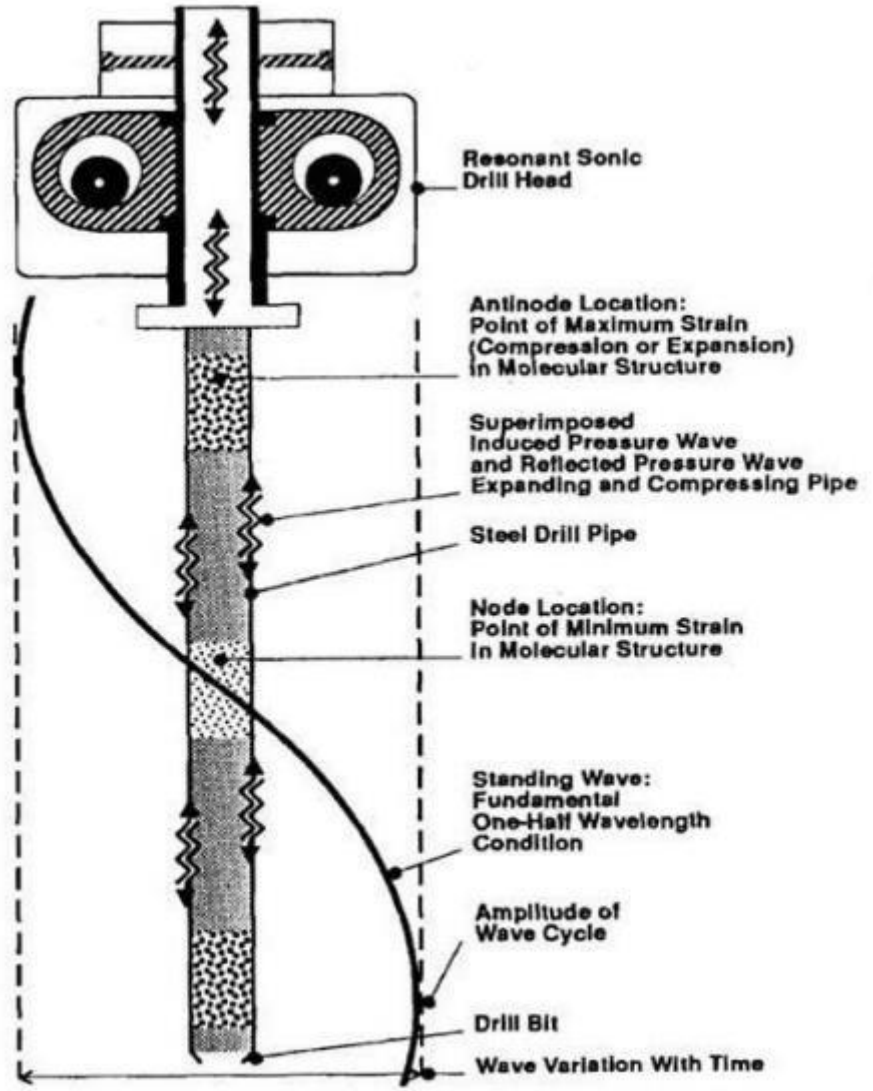


Figure 2. One-half wavelength resonant condition with no dampening.

Resonant Sonic Drill Head

High frequency mechanical oscillations, developed in the drill head, are transmitted as resonant vibrations, along with a rotary action, through the tooling to the bit to penetrate the soil or rock.

Effect of the Energy Transferred to the Drill Pipe

Energy is stored in the elastic properties of the drill pipe allowing wave propagation bringing the pipe into resonance. Resonance occurs when the frequency of the vibrations equals the natural frequency of the drill pipe.

The vibratory action fluidizes the soil particles, destroying the shear strength and pushing the particles away from the drill bit and along the sides of the drill string.

SONIC DRILLING ADVANTAGES

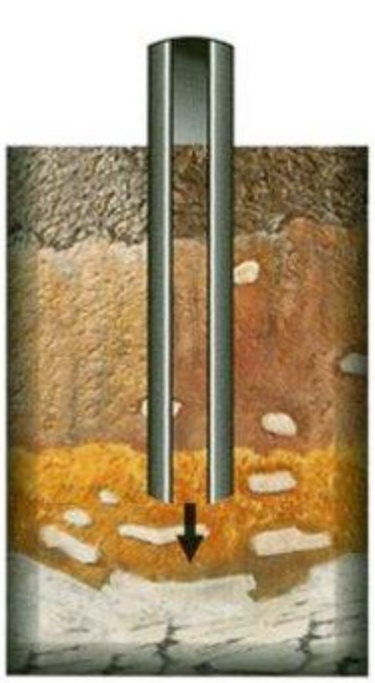
- **Speed**
  - 2-3 times faster than conventional drilling
- **Superior Information (continuous core sample)**
  - Lithology/geochemistry/hydrogeological
- **Waste Minimization**
  - ~80% less IDW than conventional drilling methods
  - Ability to “dry” drill (has limitations)
- **Better Well Construction**
  - Less development time/better yield
- **Safer and Cleaner**
  - No auger flights – just smooth drill tooling and slower rotation
  - Elevated platform
- **No refusal**
  - Drill through cobbles, boulders, & hard layers/lenses
  - Great for heaving sands
- **Flexibility and Reduced Risk for Mistakes**
  - Ability to collect discrete water samples & inject remediation fluids
  - Angle wells/multi-cased wells w/o leaving casing in ground
  - Ability to shift to split spoons, Shelby tubes, and/or coring
  - No cross-contamination

SONIC DRILLING PROCEDURE

Core Barrel Advancement

No fluids, air, or mud used during coring.

Step 1



Casing Override

Water possibly used between casings.

Step 2

Core Barrel Retrieval

Barrel retrieval for sample extrusion.

Step 3

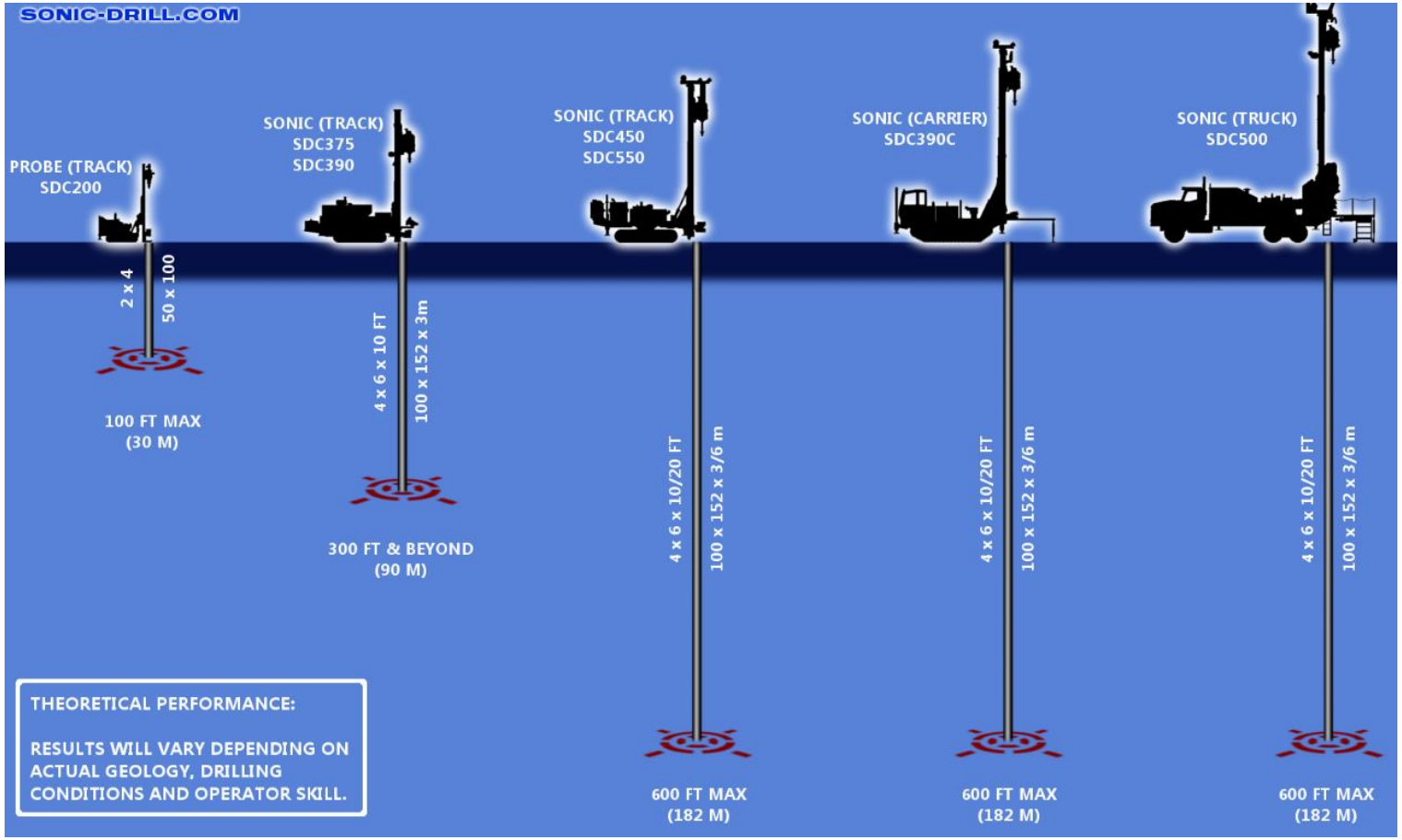
Repeat Core Barrel Advancement

Advancement following sample extrusion.

Step 4

SONIC TOOLING SIZES

- Casing Sizes – 5,6,7,8,9,10 and 12 inch
- Sample Sizes – 3,4,5,6,7 and 8 inch



CORE BARREL BITS

Standard Core Barrel Bits
Usage: Normal multipurpose operating conditions

Size	3.75 in (95.25 mm)	4.75 in (120.65 mm)	6 in (152.4 mm)	7 in (177.8 mm)	8 in (203.2 mm)
Part Number	22010819	22010807	22010818	22010806	22010890

Size	9 in (228.6 mm)	10.5 in (266.7 mm)
Part Number	22011251	22011222

Crowd-out Core Barrel Bits
Usage: Dry formations

Size	3.75 in (95.25 mm)	4.75 in (120.65 mm)	6 in (152.4 mm)
Part Number	22011178	22011160	22011163

Crowd-In Core Barrel Bits
Usage: Loose, wet conditions

Size	3.75 in (95.25 mm)	4.75 in (120.65 mm)	6 in (152.4 mm)
Part Number	22011179	22011161	22011164

Flapper Core Barrel Bits
Usage: Hole clean-out in slurry conditions (rotation not recommended)

Size	3.75 in (95.25 mm)	4.75 in (120.65 mm)	6 in (152.4 mm)	7 in (177.8 mm)	8 in (203.2 mm)
Part Number	22010863	22010821	22010824	22010827	22010892

Auger Core Barrel Bits
Usage: Hard, dry, layered conditions (helps prevents sample refusal)

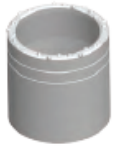
Size	3.75 in (95.25 mm)	4.75 in (120.65 mm)	6 in (152.4 mm)	7 in (177.8 mm)	8 in (203.2 mm)
Part Number	22010862	22010822	22010825	22010828	22010891

HD Core Barrel Bit
Usage: Moderately abrasive formations

Size	3.75 in (95.25 mm)	4.75 in (120.65 mm)	6 in (152.4 mm)	7 in (177.8 mm)	8 in (203.2 mm)
Part Number	22011176	22010866	22010867	22010878	22011177

HD Core Barrel Bit with Wear Plates
Usage: Severly abrasive formations

Size	3.75 in (95.25 mm)	4.75 in (120.65 mm)	6 in (152.4 mm)	7 in (177.8 mm)	8 in (203.2 mm)
Part Number	22011450	22011451	22011452	22011453	22011454



Steel Basket Core Barrel Bits
Usage: Loose, soft formations - use in conjunction with steel core basket

Size*	3.75 in (95.25 mm)	4.75 in (120.65 mm)	6 in (152.4 mm)	7 in (177.8 mm)
Part Number	22010861	22010823	22010826	22011180

Steel Core Basket
Usage: Retains loose, soft sample - use in conjunction with steel basket core barrel bit

Size*	3.75 in (95.25 mm)	4.75 in (120.65 mm)	6 in (152.4 mm)	7 in (177.8 mm)
Part Number	24690139	24690134	24690135	24690140

Plastic Basket Core Barrel Bits
Usage: Loose, soft formations - use in conjunction with plastic core basket

Size*	4.75 in (120.65 mm)	6 in (152.4 mm)
Part Number	22011162	22011184

Plastic Core Basket
Usage: Retains loose, soft sample - use in conjunction with plastic basket core barrel bit

Size*	4.75 in (120.65 mm)	6 in (152.4 mm)
Part Number	4031159	4032758

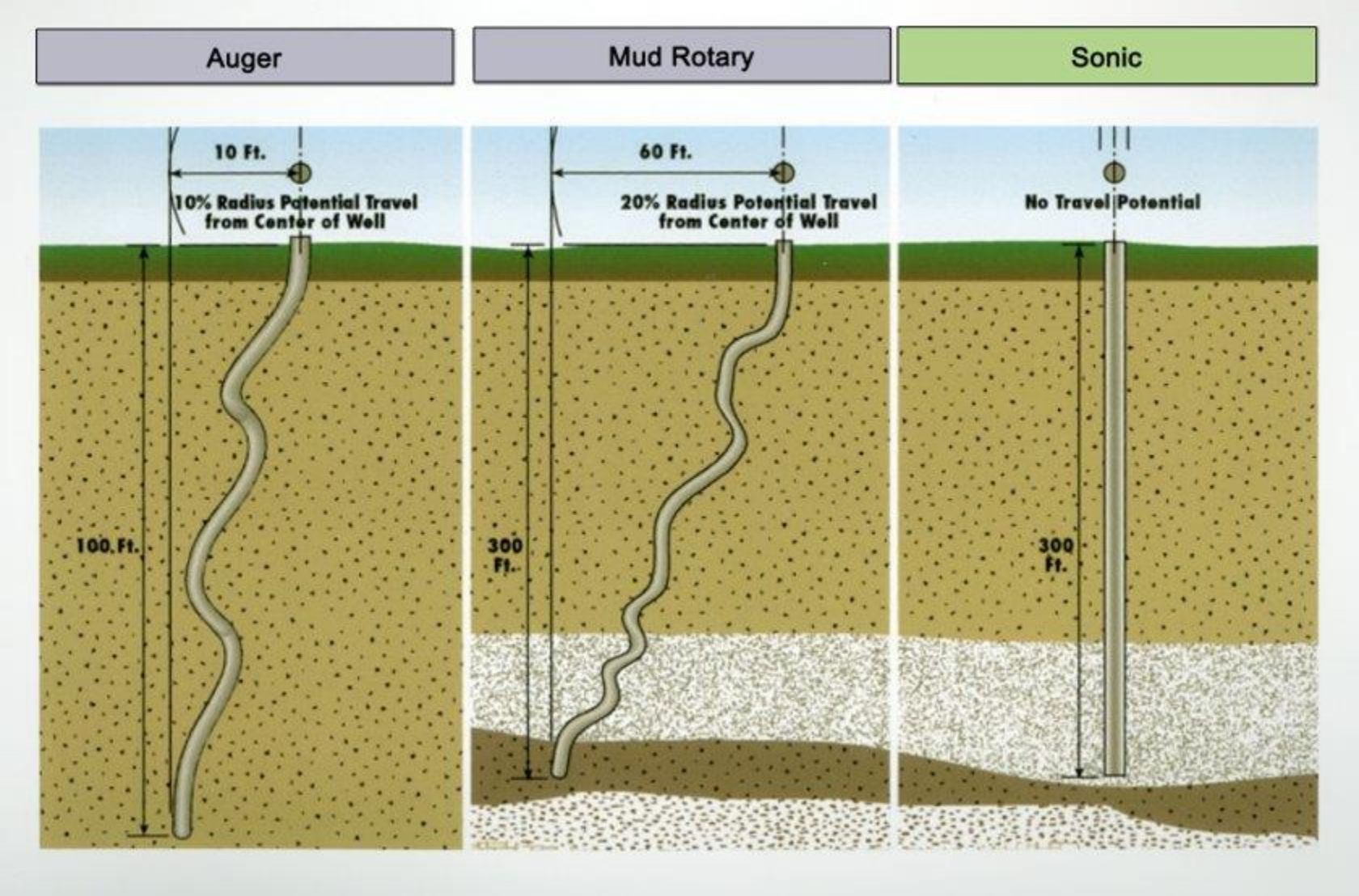
4.5 Lexan Liner Core Barrel Bits
Usage: Environmentally contaminated soils, when sample structure visibility and storage is required (Dry-drilled hole). Use in conjunction with 4.5 in solid lexan core barrel.

Size*	4.5 in (114.3 mm) Std. Lexan	4.5 in (114.3 mm) w/Flapper Lexan
Part Number	22010820	22011173

Full Face Core Barrel Bits
Usage: Drill bore holes when no sample is required.
(can also be used in conjunction with the sandstone casing shoe)

Size*	3.75 in (95.25 mm)	4.75 in (120.65 mm)	6 in (152.4 mm)
Part Number	22130594	22130568	22130578

DRILLING PRECISION



SAMPLE RECOVERY

Sample Extrusion

SOIL SAMPLING

Moose Creek Dam
North Pole, AK

Chickamauga Lock
Tennessee

COUGAR DAM, SPRINGFIELD OR

ANGLED BORINGS AND INSTRUMENTATION

Cougar Dam, Springfield, OR

CORING ROCK

McCook Quarry, Chicago

Chickamauga Lock
Chattanooga, TN

ACCESS LIMITATIONS

SONIC DRILLING COST CONSIDERATIONS

USACE Savannah District

- Sonic - $5,000/ day + materials

- Rotary - $4,000/ day + materials

TECHNICAL DRILLING CHALLENGES

Steve Widincamp – Chief, Explorations Unit, Savannah District, USACE

- Rocks lodging in core barrel shoe
- Gravel lodging between core barrel and casing
- Heaving sand
- Fines migrating to the top of core run
- Dry Drilling
- Slow penetration rate in sand

REFERENCES

- ASTM D6914/D6914M-16 Standard Practice for Sonic Drilling for Site Characterization and the Installation of Subsurface Monitoring Devices

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QUESTIONS?