Strategies for Combating Rock

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Strategies for Combating Rock

- This presentation is intended to educate project planners, contractors and HDD drill operators on the available methods of drill a wide range of rock or adverse drilling conditions.

- We will present on formation types hardness and the problems associated with these conditions.

- We will present on which solution will work in each condition.

Ground Conditions

- Know the ground conditions
  - Use local soil reports from road work surveys, etc.
  - Use local drill specialists
  - Collecting samples can be very helpful
    - Use a lab to test rocks
- Knowing the ground conditions will help you understand:
  - Productivity potentials
  - Expected tooling wear
  - Best method(s) of drilling
  - Overall cost per foot (meter)

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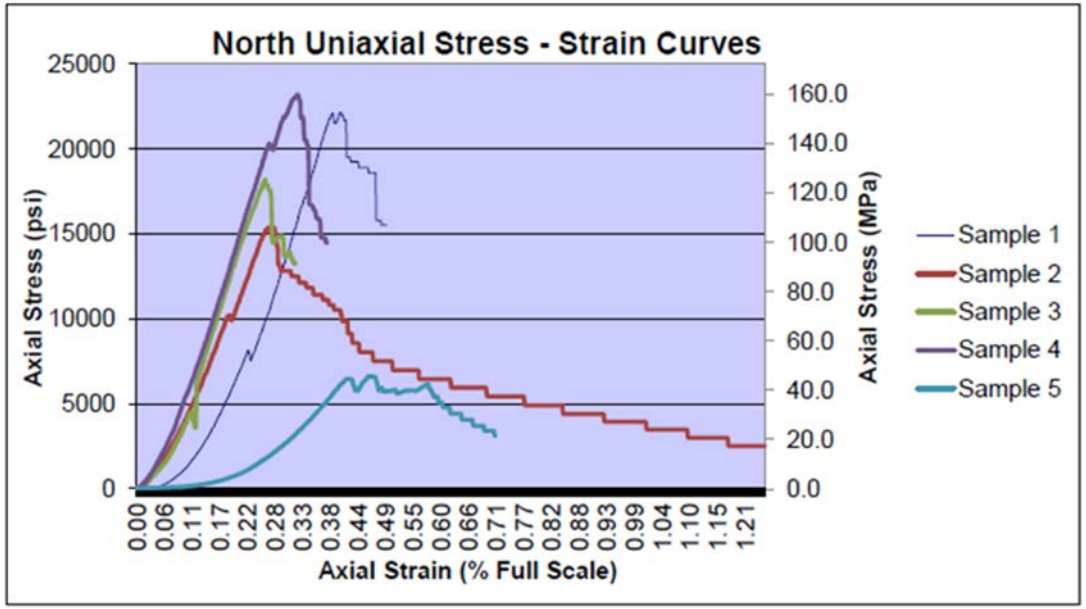


Rock Formations and Hardness

- There are a number of rock formations:
  - Rock inner mixed in loamy soils
  - Fracture and or layered rock
  - Cobble
  - Solid rock
    - Soft compressive strength rock
    - Medium compressive strength rock
    - Hard compressive strength rock





Rock Formation and Associated Problems

- Rock inner mixed in compressible soils and the problems associated
  - While utilizing a Horizontal Directional Drill (HDD), it is extremely common to hit a variety of ground condition in a single bore
    - Can make it difficult to chose the best tool for the job
  - Conditions such as layered rock and loamy soils
    - Can make it difficult to get accurate steering
    - Can easily push the drill string off target

Rock Formation and Associated Problems

- Rock drilling problems cause by layers
  - It is common to experience layered rock and soft soil conditions
  - Many HDD rock bore will experience a variety of conditions and layered throughout the bore path
  - Layers can make it difficult to steer up or down, especially at shallow angles to the layers
  - Many times layers will run at shallow angles compared to the surface making it difficult to stay on grade

Rock Formation and Associated Problems

- Rock drilling problems caused by cobble / glacial till
  - This is one of the most difficult conditions to drill
  - Rocks move making it difficult to fracture or breakup
  - The varied sized rock can shift and wedge in the bore causing additional drag on the drill rod, tooling or product.

Rock Formation and Associated Problems

- Rock drilling problems related to solid formations
  - Solid rock is one of the more predictable rock types to drill
    - Even though solid rock may be predictable to drill, it does not mean it is easy to drill or that you will have good productivity
    - You may experience a variety of hardness so method selection is critical
    - It is common to drill through soft soils before hitting solid rock so productivity may be compromised due to tooling requirements

Rock Formations and Definitions

- Solid soft compressive strength rock drilling:
  - For the purposes of this discussion, we will be referring to rock with 10,000 psi compressive strength or lower
- Primary drilling methods:
  - Specialty bit drag cutting with bits, such as the Vermeer Armor system
  - Rotary drilling with dual rod machines, such as Vermeer D40x55DR S3 NAVIGATOR® HDD
  - Mud motor drilling
  - Air hammer drilling with the use of Mincon air hammers

Rock Formations and Definitions

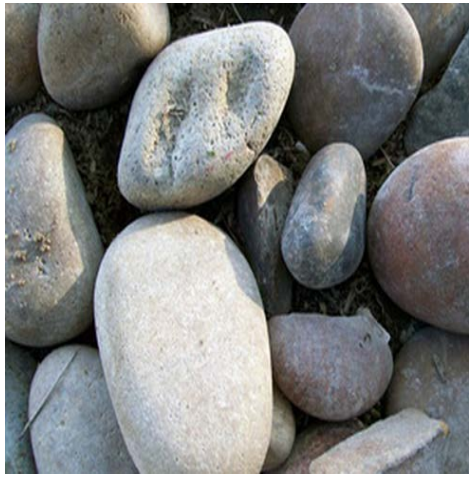
- Solid medium compressive strength rock drilling
  - For the purposes of this discussion, we will be referring to medium rock with 8,000 -25,000 psi compressive strength
- Primary drilling methods:
  - Rotary drilling with dual rod machines
  - Mud motor drilling
    - Air hammer drilling, such as air tools like a Mincon air hammer

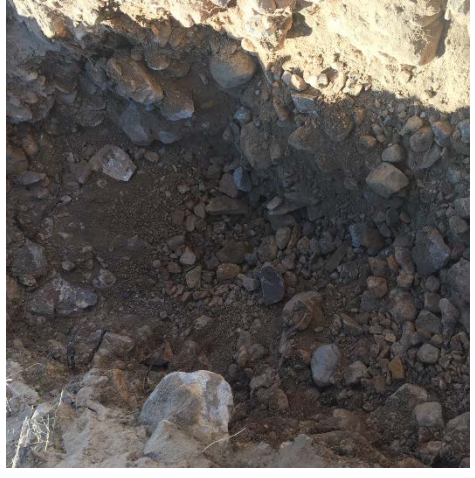
Rock Formations and Definitions

- Hard compressive strength rock drilling
  - For the purposes of this discussion, we will be referring to medium rock with 20,000 psi compressive strength and higher.
  - Primary drilling methods:
    - Mud motor drilling
    - Rotary drilling with dual rod machines
    - Air hammer drilling, such as air tools like a Mincon air hammer

Specialty Bits

- Specialty drag cutter bits qualified for soft rock up to 10,000 psi (690 bar)
- Single roller cones can help extend your ability to drill in rock with a conventional drill and no additional equipment





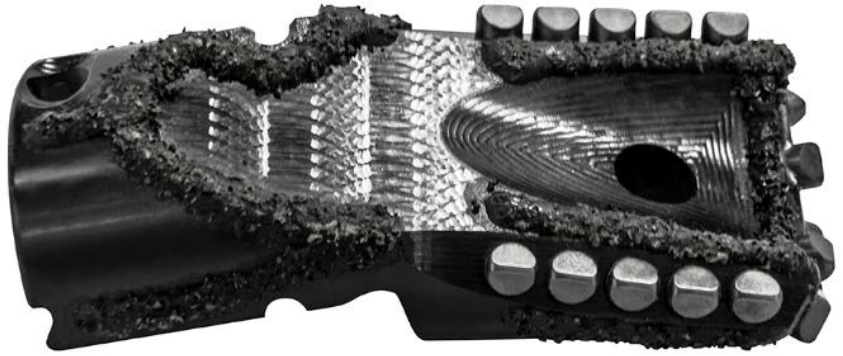
Soft Rock Drag Cutter Bits

Conical carbide tooth bit

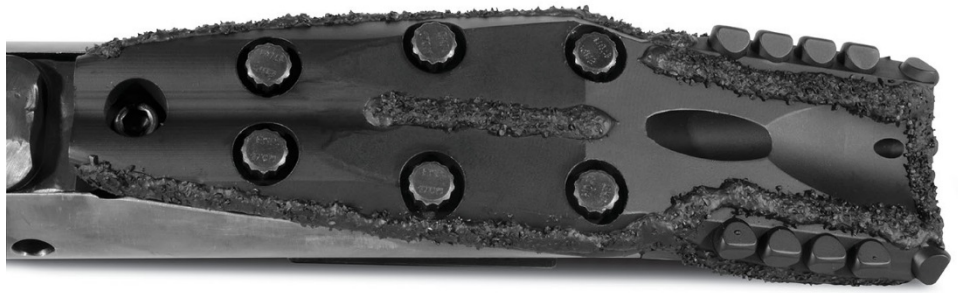
- Application: soft to medium rock, shale and caliche up to 10,000 psi (689.5 bar)
- Replaceable rotary teeth to “claw” and fracture the rock
- Example: Vermeer Armor Gauntlet™ bit

Fixed carbide chisel teeth bit

- Application: hard-packed soil, gravel and cobble
- Scoop design to help limit wandering in tough conditions
- Oversized carbide buttons and carbide grit hardfacing for wear reduction and rock fracturing
- Example: Vermeer Armor Lance™ bit



Bolt on Specialty Drag Cutter Bits



- Fixed carbide chisel teeth bit
  - Example: Vermeer Armor Lance
- Bolt one conical carbide tooth bit
  - Gauntlet bits also available in bolt-on
- Compatible with Vermeer premium housing only

Drag Cutter and Single Roller cone bits

Domed carbide bit

- Additional carbide specialty pit offerings with domed, plug-style carbide teeth
- Example: Vermeer Armor Lance™ Pro bit

Single roller cone

- Application: Cobble, broken formations and soft to medium rock
- Cone rotation helps minimize torque spikes
- Example: Vermeer Armor single roller cone bit

Mud Motor / Rotary Cutting

Mud motors

- Are versatile tools that fit a wide range of HDD machines
- Can use a wide range of bits
  - Roller cones, mill tooth and TCI
  - Drag cutters
    - PDC
    - Chevron style bits
- Can drill a wide range of rock and soil conditions
  - Rock inner mixed in loamy soils
  - Fracture and or layered rock
  - Cobble
  - Solid rock
    - Soft compressive strength rock
    - Medium compressive strength rock
    - Hard compressive strength rock
- Does utilize a large amount of flow

Dual Rod / Mechanical Motor Drills

Dual rod machines

- Can be used with a wide range of tooling and bits based on ground conditions
  - Roller cones, mill tooth and TCI
  - PDC
  - Dirt heads with plate bits
  - Armor System
  - Reamers
    - Drag cutters
    - Hole openers
  - Air Hammers

Dual Rod / Mechanical Motor Drills

Dual rod machines, like the Vermeer D40x55DR S3 help provide:

- Easier rock drilling operation, similar to single rod machine operation and mud motor
- Low fluid flow requirements
- Versatile machine fit a wide range ground conditions
  - Loamy soils
  - Rock inner mixed in loamy soils
  - Fracture and or layered rock
  - Cobble
  - Solid rock
    - Soft compressive strength rock
    - Medium compressive strength rock
    - Hard compressive strength rock

Dual Rod / Mechanical Motor Drills

- Dual rod machines, such as the Vermeer D40x55DR S3 in combination with an air hammer
  - Can help drill the full range of rock conditions
    - Rock inner mixed in loamy soils
    - Fracture and or layered rock
    - Cobble
    - Solid rock
      - Soft rock
      - Medium rock
      - Hard rock
  - When drilling hard rock the dual rod machine, in combination with an air hammer, can help improve productivity over conventional drill bits


Support Station
Manual Oiler
Remote Oiler
HDD 80PR
HDD 70PR
HDD 90
HDD 60
HDD 70
HDD 50
HDD 40
HDD 30

Rig / Hammer Range

HDD 30 (3.25")

HDD 40 (4.25")

HDD 50 (5.25")

HDD 50 (5.25")

HDD 60 (6.25")

HDD 70 (7.5")

HDD 90 (9.25")

HDD 90 (9.25")

- Easily adapts and operates on conventional drill
- Dual steering point design, incorporating slant bit and 2 degree bent sub provides more responsive steering capabilities while transitioning in and out of rock formations.
- High frequency hammer cycles (2100-2300 hits per minute) create an extremely smooth low vibration reaction to the rig and to the electronics.
- With the high frequency cycles, the rock formations fracture into smaller pieces which are easier and faster to flush out of the hole. This helps increase the production rates and steerability.

Pilot Bits

Standard Slant

Heavy Duty Slant

Convex

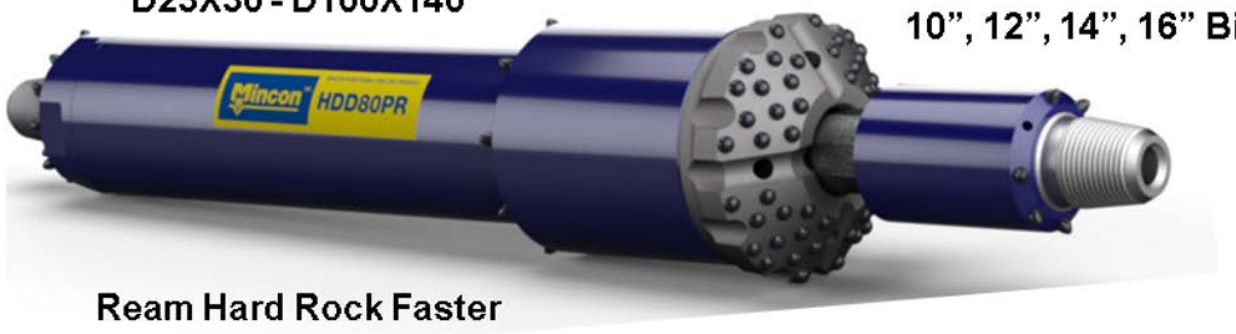
Hammer Steering

Hammer Reamer Solutions

Rock Reaming Solution For Small Rigs (D10X15 - D23X30)

7”, 8”, 9” Bits

D23X30 - D100X140



10”, 12”, 14”, 16” Bits

Ream Hard Rock Faster

Hammer Reaming

Air Compressor Requirements

Aftercooled Air Recommended

Vermeer HDD Model Mincon Hammer Model		D10X15 HDD30	D20X22 HDD40	D23 D24 HDD50	D40 D60 HDD60	D100X140 HDD70	D220 D330 HDD90
Pilot Bit Size	Metric	89 mm	108 mm	133 mm	159 mm	190 mm	235 mm
	Imperial	3.5"	4.25"	5.25"	6.25"	7.5"	9.25"
Recommended Air	Metric	177 l/s @ 17.2 Bar	189 L/S @17.2 Bar	354 l/s @24.1 Bar	425 l/s @ 24.1 Bar	425 l/s @ 24.1 Bar	519 l/s @ 24.1 Bar
Less 250' / 76.22 M	Imperial	370 cfm @ 250 psi	400 cfm @ 250 psi	750 cfm @ 350 psi	900 cfm @ 350 psi	900 cfm @ 350 psi	1100cfm @ 350psi
Recommended Air	Metric	236 l/s @24.1 Bar	330 l/s @24.1 Bar	425 l/s @ 24.1 Bar	519 l/s @ 24.1 Bar	519 l/s @ 24.1 Bar	590 l/s @ 24.1 Bar
Over 250' / 76.22 M	Imperial	500 cfm @ 350 psi	700 cfm @ 350 psi	900 cfm @ 350 psi	1100cfm @ 350psi	1100cfm @ 350psi	1250cfm @ 350psi
Backhead Thread		2 3/8" API Reg Pin	2 3/8" API Reg Pin	2 3/8" API Reg Pin	3.5" API Reg Pin	3.5" API Reg Pin	4.5" API Reg Pin
Mincon PullReamer			HDD70 PR	HDD70/80 PR	HDD80 PR	HDD80 PR	
Bit Sizes			7" 8" 9"	7"8"9"/10"-16"	10"12"14"16"	10"12"14"16"	
Recommended Air	Metric		425 l/s @ 24.1 Bar	425 l/s @ 24.1 Bar	425 l/s @ 24.1 Bar	425 l/s @ 24.1 Bar	
Less 250' / 76.22 M	Imperial		900 cfm @ 350 psi	900 cfm @ 350 psi	900 cfm @ 350 psi	900 cfm @ 350 psi	
Recommended Air	Metric		590 l/s @ 24.1 Bar	590 l/s @ 24.1 Bar	590 l/s @ 24.1 Bar	590 l/s @ 24.1 Bar	
Over 250' / 76.22 M	Imperial		1250 cfm@350 psi	1250 cfm@350 psi	1250 cfm@350 psi	1250 cfm@350 psi	



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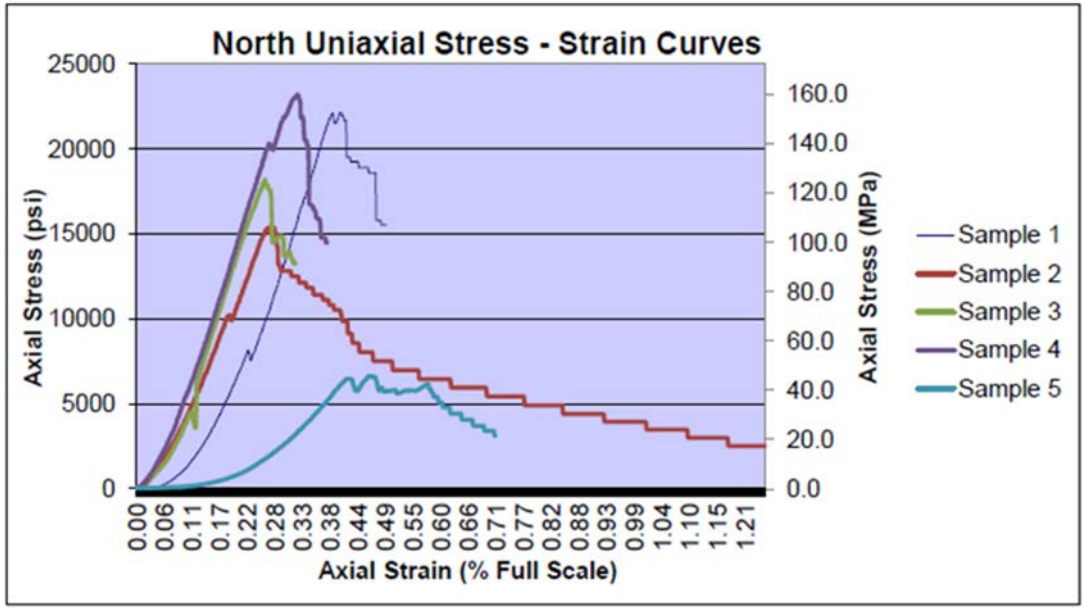

Vermeer

EQUIPPED TO DO MORE.