HORIZONTAL DIRECTIONAL DRILLING

--- RISK ASSESSMENT ---

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PERILS OF HDD

UNDERGROUND WHERE WE CAN’T SEE
TO PLAN, DESIGN, USE OR APPROVE HORIZONTAL DIRECTIONAL DRILLING, YOU MUST UNDERSTAND HOW IT WORKS

THERE ARE REALLY ONLY TWO BASIC TYPES OF INSTALLATION METHODS REGULARLY USED IN TRENCHLESS TECHNOLOGY TO INSTALL PIPES OR PIPELINES UP TO ABOUT 48” IN DIAMETER …

- PIPE JACKING OR MICROTUNNELING
  - Which doesn’t require an oversized hole
- HORIZONTAL DIRECTIONAL DRILLING
  - Which does require an oversized hole

✓ HDD CAN GO FARTHER AND IS NEARLY ALWAYS CHEAPER IF FEASIBLE
BASIC HDD EQUIPMENT:

- Drilling rig
  - power control module
  - Drilling cab

- Mud mixing tank
  - Mud cleaning equipment
    - Centrifuge

- Mud pump

- Pipe handling equipment

- Miscellaneous things
TYPICAL RIG SIDE LAYOUT

1. Rig Unit
2. Control Cab Power Unit
3. Drill Pipe
4. Water Pump
5. Slurry Mixing Tank
7. Slurry Pump
8. Bentonite Storage
9. Power Generators
10. Spares Storage
11. Site Office
12. Site Office
13. Entry Point Slurry Containment
14. Cuttings Settlement Pit
BASIC HDD OPERATIONS

- DRILLING THE PILOT HOLE
- ENLARGING (PRE-REAMING) THE PILOT HOLE
- CLEANING THE REAMED HOLE
- PULLING A PIPELINE INTO THE CLEANED HOLE
THE PILOT HOLE CAN BE DRILLED WITH EITHER A ---

- Hydraulic “jet bit assembly” for softer soils
- Or a “downhole motor” for harder materials
DOWNHOLE TOOLING

Drill Pipe

Survey Probe

Bent Motor

Non Magnetic Collars

Drill Bit

Approx 1.5 deg.
BASIC STEERING TOOL

Lateral and vertical accuracy measures 0.2 ft/10 ft of borehole depth (2%).
TENSOR STEERING TOOL WITH ITS PATENTED TRUTRACKER

TruTracker’s accuracy is rated to +/- 2% of the vertical depth up to 200 feet
PARATRACK STEERING TOOL WITH INTERSECTION CAPABILITY

ParaTrack’s accuracy is also rated to +/- 2% of the vertical depth
Drillguide GST (first gyroscopic tool for HDD) was introduced in North America in 2007. It is not affected by DC current, AC current or extraneous magnetic anomalies. It is currently “proprietary” and also relatively expensive to use.

Accuracy of the GST tool is 0.04° of azimuth and 0.02° of inclination.
FLYCUTTER AND BARREL REAMER FOR SOFTER MATERIAL
HOLE OPENERS FOR HARDER ROCK
EARLY SUCCESSES AND FAILURES ALLOWED US TO FORMULATE SOME BASIC DESIGN PARAMETERS

A. WALL THICKNESS - D/T “RULE OF THUMB” - The following table provides generalized recommendations for the selection of steel pipe wall thicknesses relative to pipe diameter. These recommendations are meant to be used only as a starting point in the design. It is recommended that in the final design, specific stresses be calculated and compared with allowable limits.

<table>
<thead>
<tr>
<th>Diameter (D)</th>
<th>Wall Thickness (t)</th>
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<tbody>
<tr>
<td>6 in. and smaller</td>
<td>0.250 in.</td>
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<tr>
<td>6 to 12 in.</td>
<td>0.375 in.</td>
</tr>
<tr>
<td>12 to 30 in.</td>
<td>0.500 in.</td>
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<tr>
<td>For 30 in. and larger, D/t ≤ 50</td>
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(For high-density polyethylene (HDPE) pipe, a standard dimension ratio of D/t, SDR, of 11 or less is recommended and the pipe manufacturer should be consulted.)

2. Precam - Once the pilot hole is complete, the hole must be enlarged to a suitable diameter for the product pipeline. For instance, if the pipeline to be installed is 36 in. diameter, the hole may be enlarged to 48 in. diameter or larger. This is accomplished by “prereaming” the hole to successively larger diameters. Generally, the reamer is attached to the drill string on the bank opposite the drilling rig and pulled back into the pilot hole. Joints of drill pipe are added as the reamer makes its way back to the drilling rig. Large quantities of slurry are pumped into the hole to maintain the integrity of the hole and to flush out cuttings.

1. ASME B31.8 - 1992, Table A842.22 provides the following limits:
- Maximum allowable longitudinal stress: 80% SMYS.
- Maximum allowable hoop stress: 72% SMYS.
- Maximum allowable combined stress: 90% SMYS. (Where SMYS is the Specified Minimum Yield Strength of the pipe material.)

It is normally recommended that the minimum depth of cover be 20 ft under the lowest section of the crossing. While 20 ft is a recommended depth of cover on a river crossing, crossings of other obstacles may have differing requirements.

It is preferable that straight tangent sections are drilled before the introduction of a long radius curve. The radius of the curve is determined by the bending characteristic of the product pipeline, increasing with the diameter. A general “rule-of-thumb” for the radius of curvature is 100 ft/1-in. diameter for steel line pipe.
HOW TO ASSESS AND EVALUATE THE RISKS ASSOCIATED WITH A HORIZONTALLY DRILLED PIPELINE INSTALLATION

WHAT GENERAL RISKS ARE ASSOCIATED WITH HDD?

- Lost Returns (Frac Outs!) and Cavitation which can lead to …
  - Subsidence damage to surface structures
  - Slumping and slope failures
- Contamination
- Direct impact damage to other underground utilities
- Disruption and/or damage to aquifers
EXAMPLE: DAMAGE TO SURFACE STRUCTURES
EXAMPLE: DAMAGE TO SURFACE STRUCTURES
EXAMPLE: FRAC OUT
EXAMPLE: FRAC OUT
EXAMPLE: SLOPE FAILURE
HOW TO ASSESS AND EVALUATE THE RISKS ASSOCIATED WITH A HORIZONTALLY DRILLED PIPELINE INSTALLATION

HOW CAN WE AMELIORATE THESE RISKS?

- BY THOROUGHLY UNDERSTANDING TRENCHANTLESS CONSTRUCTION METHODS AND THEIR LIMITATIONS – then making the right choice
  - REMEMBER – HDD uses relatively high pressure fluid flow to cut through the underground soils; other trenchless methods don’t!
  - REMEMBER – HDD requires an annular space for these fluids to transport cuttings back to the surface; other trenchless methods don’t!
- THEN BY SOUND ENGINEERING AND PLANNING
HOW TO HELP PREVENT OR MITIGATE RISKS ASSOCIATED WITH A HORIZONTALLY DRILLED PIPELINE INSTALLATION

HDD’s need for high pressure drilling fluid and an annular space around the drill pipe and pipeline is largely responsible for creating these risks.

RISK EVALUATION METHODS (WHAT YOU NEED TO SEE TO MAKE DECISIONS) …

- Exploration Program
  - Subsidence Study
  - “Frac Out” Analysis
    - Possibly use of a Mud Recovery System
- Designing by experienced engineers
  - Use of Surface Casing
  - Use of Grouting
  - Often by just drilling deep!
PREVENTING DAMAGE TO SURFACE STRUCTURES
PREVENTING CONTAMINATION

CASING
CASING, M.R.S.,
DRILL DEEPER
At this point I think it’s best to take questions

Ron Halderman