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Ensuring Coating Integrity for HDD Application

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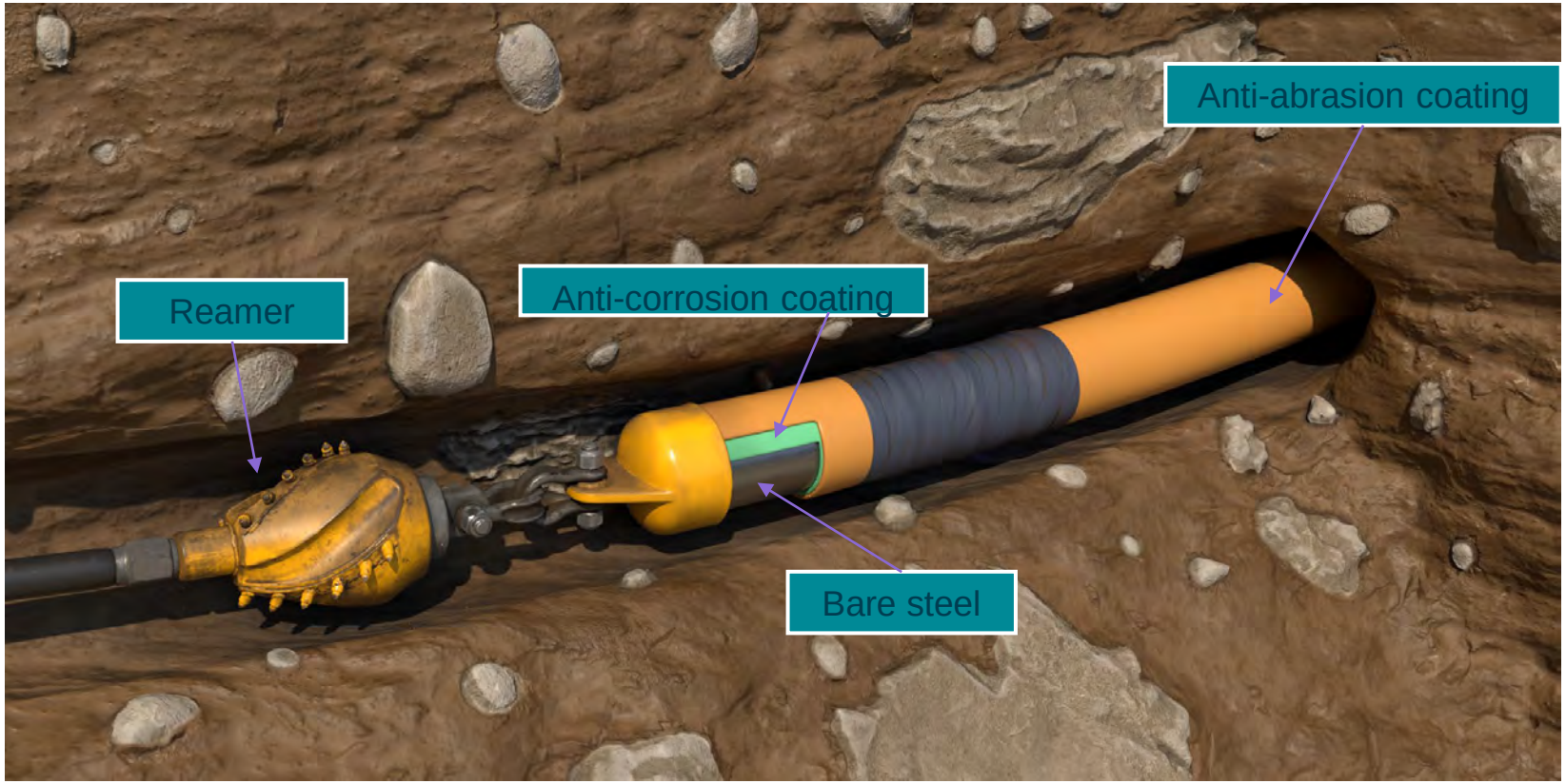
Agenda

1. What is an HDD?
2. Coatings Selection for HDD Applications
   - Federal Guidelines and Commonly used HDD coatings in North America
3. Performance of Existing Coatings
   - Corrosion Coating Options
4. Composite Technology Introduction
   - Installation is Key
5. We are going to talk about Case Histories

WHY USE HDD ?

- Trenchless technology for laying pipelines
- Inaccessible area for trenching
- Structure, geographical, population impact
- Used at river crossings, under roadways, railroad tracks, etc.
- Most of the areas are what is known as HCAs (high consequence areas)

HDD Installations



→ There is not a “universal” HDD project. (soil conditions, pipe OD, bore hole OD, drill angle, experience of the contractor… Every HDD project has unknowns.

HDD Damage

- Gouging
- Abrasion
- Extreme Shear
- Impact
- Bending Loads

Long Term Damage

- Moisture Ingress
- Penetration
- Cathodic Disbondment

HDD Cost Implications

- Soil conditions
  - How accurate are the soil surveys?
- Spot repairs
  - Will the coating survive pull back?
  - Will spot repairs be possible?
- Costly repairs
  - How much are re-pull and repair cost if it fails?
- Regulation criteria
  - Does the project require a post bore inspection? Visual? Coating conductance testing?
  - Are we meeting the CFR:192.461-USA standard? "Precautions must be taken"

Federal Guidelines for PL Coatings

CSA Z662 Clause 9.2.2

For the coating system being considered, the factors given in Column 1 of Table 9.1 shall be evaluated as applicable to identify the coating properties and characteristics necessary for satisfactory coating performance and to identify situations along the pipeline where coating performance problems are likely to occur. Particular attention shall be given to situations such as

a) trenchless installations (e.g., bored crossings, horizontal directional drills) and installations involving padding, backfilling, or bending;

Federal Guidelines for PL Coatings (continued)

49 CFR 192.461 External protective coatings

(a) Each external protective coating, whether conductive or insulating, applied for the purpose of external corrosion control must -

(1) Be applied on a properly prepared surface;

(2) Have sufficient adhesion to the metal surface to effectively resist under film migration of moisture;

(3) Be sufficiently ductile to resist cracking;

(4) Have sufficient strength to resist damage due to handling and soil stress; and

(5) Have properties compatible with any supplemental cathodic protection.

(b) Each external protective coating which is an electrically insulating type must also have low moisture absorption and high electrical resistance.

(c) Each external protective coating must be inspected just prior to lowering the pipe into the ditch and backfilling, and any damage detrimental to effective corrosion control must be repaired.

(d) Each external protective coating must be protected from damage resulting from adverse ditch conditions or damage from supporting blocks.

(e) If coated pipe is installed by boring, driving, or other similar method, **precautions must be taken** to minimize damage to the coating during installation.

What guidance is given in Australian Standards?

Coating Selection for HDD Applications

How do you define?
“precautions must be taken”
“particular attention”

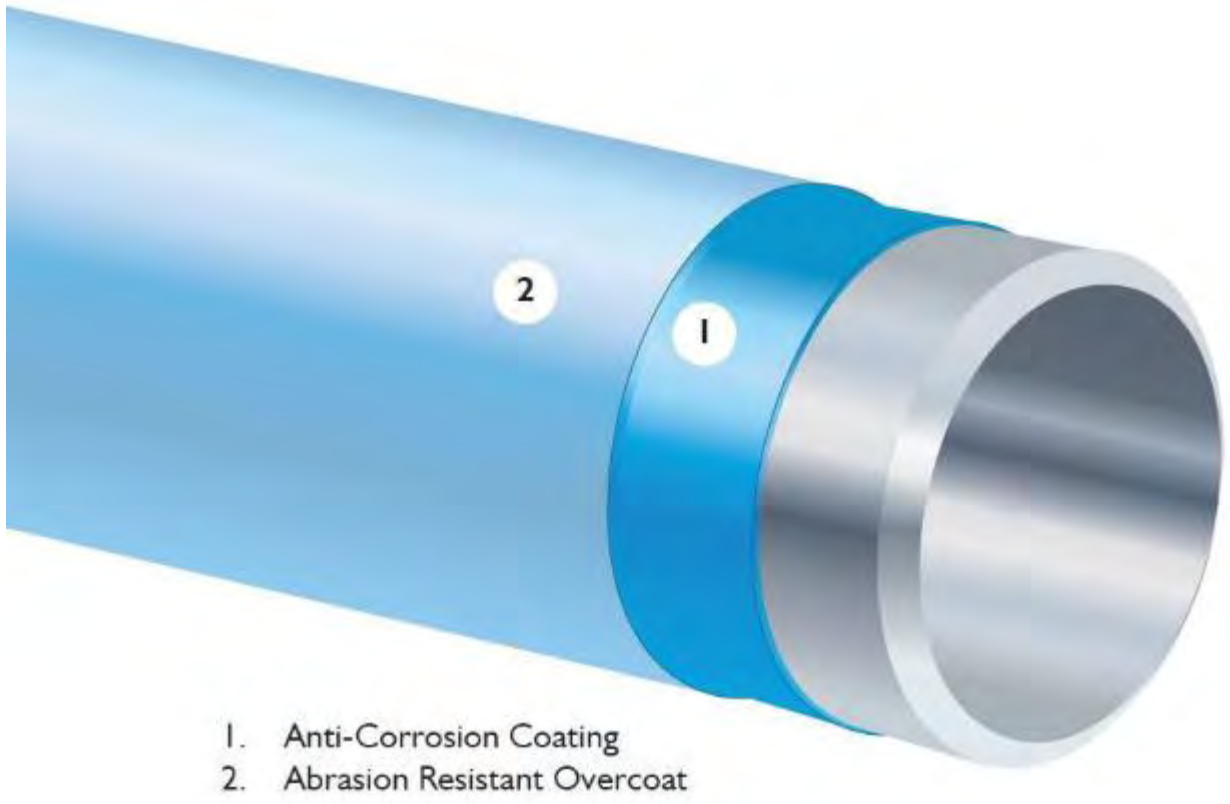
Will the coating survive an HDD?
Will CP be effective?

CONSIDERATIONS FOR EXTERNAL COATINGS

- Standard performance tests for carrier pipe coating
- Coating must also be rated for resistance to damage during HDD installation
- Compatibility with CP system important

Typical Mainline Coating for HDD Applications

- **Dual Layer FBE (FBE + ARO)**
- **FBE with 40 mils of Liquid Epoxy (ARO)**



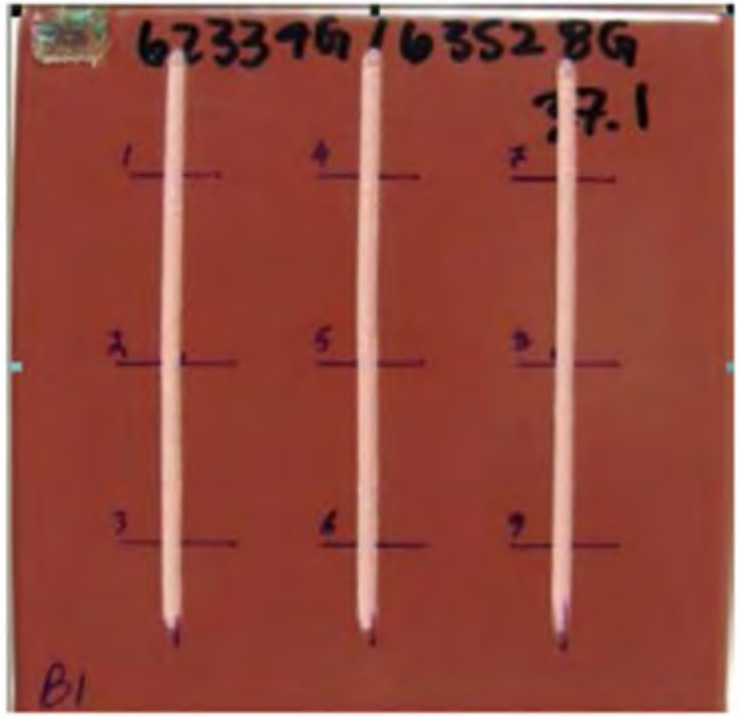
Typical Field Joint Coatings for HDD Applications

- **Two-Part Liquid Epoxies**
- **Multi-Layer Heat Shrink Sleeves**

Most HDD projects in the USA use a thicker 2-part epoxy for the field joints. (~60 mils)

Typical HDD Coating Properties and Testing

- Adhesion
- Abrasion
- Gouge Resistance
- Impact
- Hardness
- CP Compatibility



Gouge Test Results

Performance values listed on a product data sheet are not a good indicator of how the product will perform on an HDD.

Why do we get severe damage during HDDs?

- Basic Physics – dragging pipe through unknown soil conditions.
- Coatings are stretched to their limits
- Core / soil samples are not always accurate.
- The soil survey for this project was classified as “good drilling conditions”

Typical Causes of Coating Damage During HDD Installations

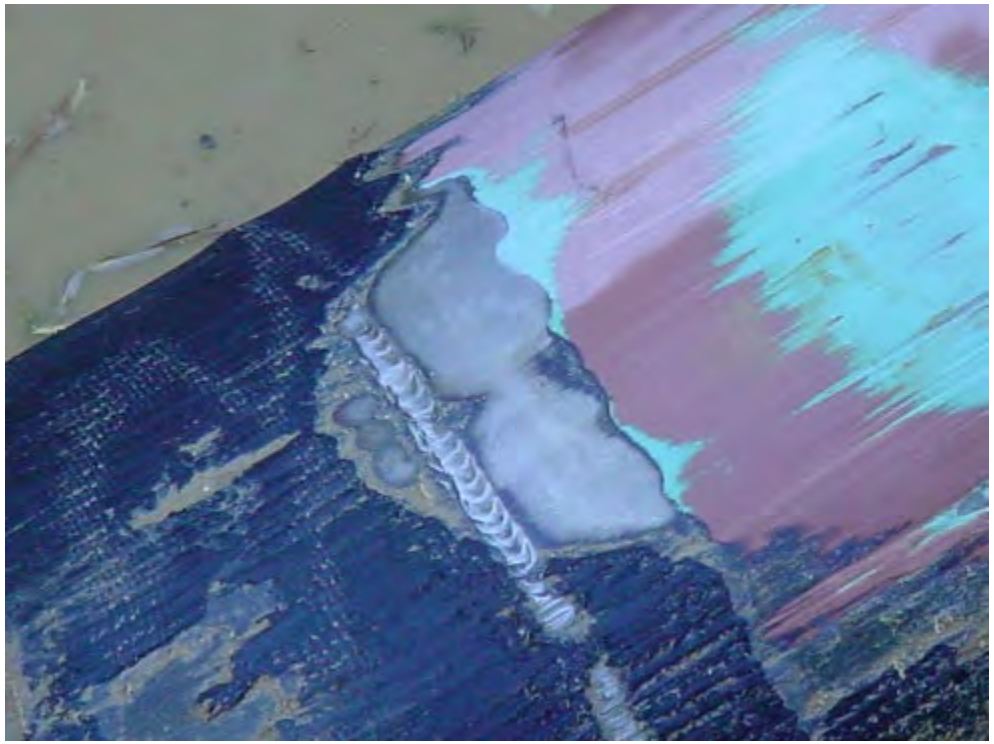
- Installation
- Abrasion
- Shear Disbondment
- Impact
- Bending load
- Jobsite hazards

SHEAR DISBONDMENT

Typical Results of Field Joint Coatings After HDD

Failure of Two-Part Epoxy

Failure of 3LPE based system



The Field Joint Coatings have always been the weak link during HDDs. Why?

- Raised girth weld experiences maximum abrasion, gouge and impact forces
- Performance data is not pulled from the girth weld location
- Difficult to build consistent epoxy thickness over the girth weld
- Impossible to pull a wet film thickness over the girth weld
- Difficult to read a dry film thickness on the girth weld
- Trying to increase epoxy thickness (60+ mils) over the girth weld results in cracking

The corrosion coating at the girth weld, which is where we see the most abuse, is typically assessed on a visual guess

Strength, Stiffness and Fracture Toughness

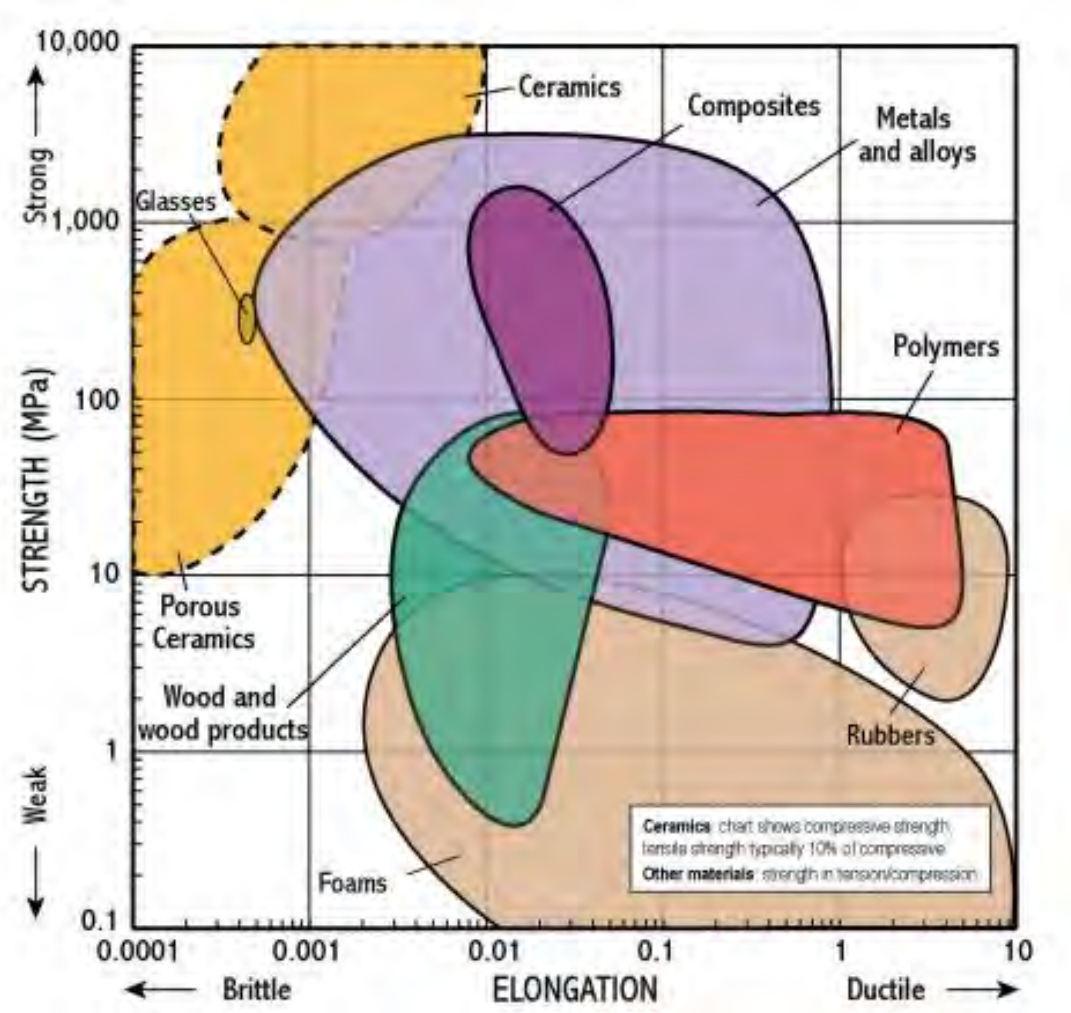
- Historical testing parameters/properties do not include fracture toughness in decision making process
- Why is fracture toughness so important?

Strength

- How strong a material is, measured in psi(Pa)

- Chart shows strength Weakest to strongest – bottom to top

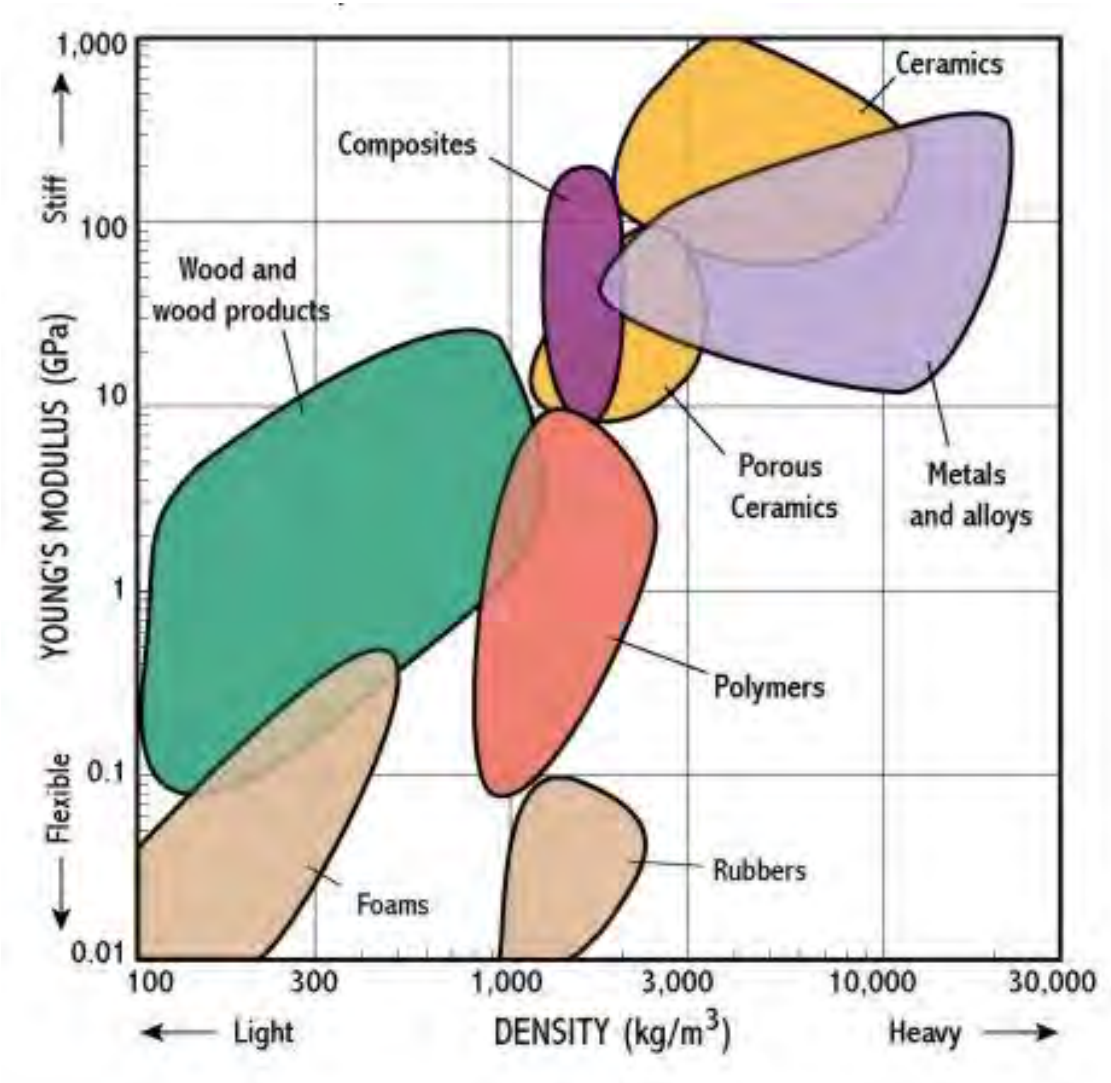
- **Practical example:**
- Ceramics are strong, Foam is not
- Glass Composite – 80,000 psi
- Epoxy Coating – 10,000 psi



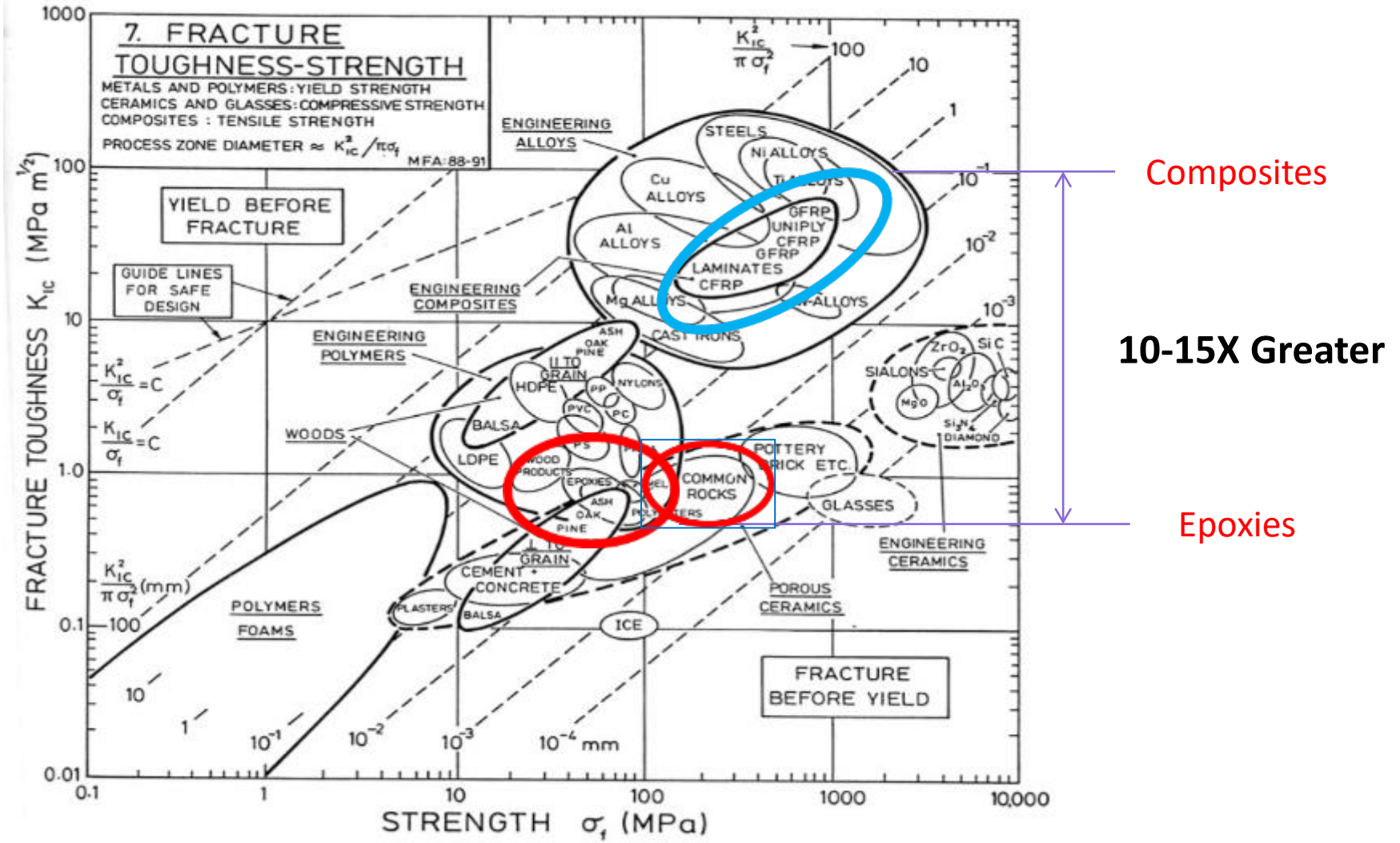
Stiffness

- How resistant to deformation a materials is measured in psi(Pa).

- Chart shows Stiffness, Highest to Lowest – bottom to top
- Composite 4,000,000 psi
- Epoxy Coating 250,000 psi



Fracture Toughness – Energy required to crack a material. Most important for materials that suffer from impact.



Composites

10-15X Greater

Epoxies

Epoxy Coatings vs. Composite Technology

Fracture Toughness (K_{IC}) Values	
Epoxy FJC (A)	2,112
Epoxy FJC (B)	2,245
FRP (B)	34,378

Composite Technology

- 10-30 times stronger
- 10-20 times stiffer
- 10-15 times greater fracture toughness

On many composite field joint projects, the FBE/ARO main line coating is damaged down to the steel pipe. The composites product that was used on the field joints has done its job in protecting the anti-corrosion coating underneath.

Conclusion

- Strength of composite are about 10-30 times greater than Epoxies
- Stiffness of composites are about 10-20 times greater than epoxies
- Fracture Toughness of composites are about 10-15 times greater than epoxies

Composites offer an undeniable advantage in performance over Epoxies

Composite Technology

Is a fibreglass cloth, preimpregnated with a resin that can be activated by salt or freshwater to coat and protect within minutes. The product is formulated to resist shear, impact and abrasion on pipe coating systems.

Superior Mechanical Protection

- Provides unparalleled protection against impact, indentation, abrasion, punctures & tears that may result during directional drilling.
- Designed to protect the underlying field joint coating from the effect of forces associated with directional drill.

Long Term Corrosion Protection

- In combination with a heat shrinkable sleeve or liquid epoxy the composition of products provides an effective barrier to water and oxygen which provides effective corrosion protection and soil stress resistance.

Chemical Resistance

- Resistant to corrosive salt water, soil acids, alkalis and salts, common chemicals, chemical vapors and exposure to outdoor weathering and sunlight.

Non Shielding

- This product will not shield cathodic protection

Composite Installation

Anti-corrosion coating installation.
Surface Preparation
Holiday Test

Composite Installation
Single Pass, 50% Overlap
Water Activation

Compression Film Installation
Two Passes, 50% Overlap

Perforate Compression Film

Allows water and CO^2 to escape

Composite is ready to pull when Shore D is > 60

Average cure time is approximately 30 minutes with 40C surface temperature.

Full Encapsulation - Crew Size

Role	Operators
Composite application	2
Water spraying	1 to 2
Compression film application	2 to 4
Perforating compression film	1 to 2
Staging (retrieving composite rolls, refilling water sprayers, etc.)	1

Compression film can be applied using either 4 operators and applying two passes of compression film using a 50% overlap or using 2 operators and applying a single pass of compression film using a 75% overlap.

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Cold Weather Installation

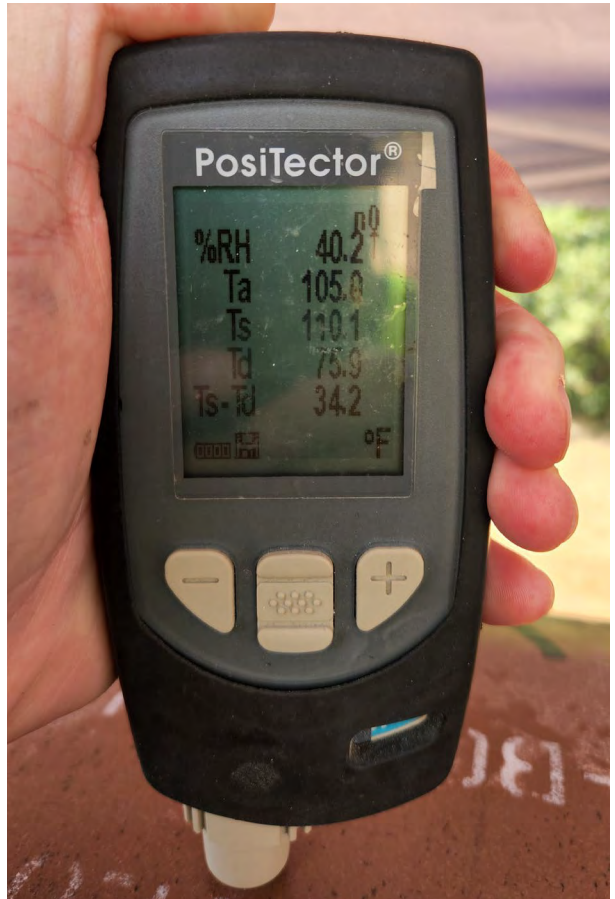
Like most liquid coatings, polyurethanes do not cure quickly under 10C

- Preheat the corrosion coating prior to installation (40C to 60C)
- Keep the packaged composite material in a warm location
- Use warm water
- Add Propylene Glycol 33% will allow curing to -17 C
- Girth Welds can be heated with an electric blanket or hot water drenching after application

Hot Weather Installation

Like most liquid coatings, polyurethanes cure quicker as the temperature increases

- 40C to 60C can cause very quick cure times and can cause foaming
- Keep the packaged composite material in a cool location such as an ice chest
- Use cold water, including adding ice to the sprayers
- Covering the application area with tents and spraying the pipe down with cold water



Weld bead protection is critical for a successful HDD project!

If the mainline coating requires the use of an abrasion resistant overcoat, the field joint coating should as well.

An easily applied solution exists that can protect the most difficult application on HDD projects.

Results after HDD pull back

30” OD Pipe – shale conditions, damage to ML ARO

Results after HDD pull back

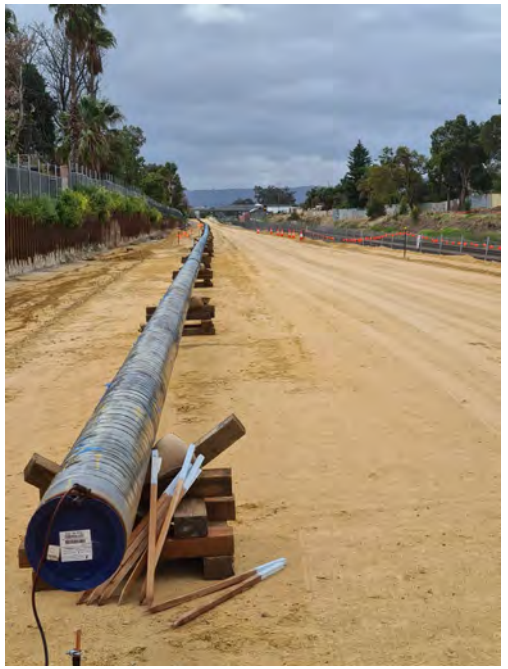
1,400’ of 30”, LE with Composite Wrap

The Mainline coating is now the weak link in HDD applications.

Composite Wrap Protecting ML Coatings

CANUSA-CPS SCAR-GUARD PROJECT SUCCESS:

Project Name	KWOL
Year	2021
Market	Onshore, Mixed Use Pipeline
Country or Location	Australia
Scope	Full Encapsulation for HDD 12,000m
Diameter	12” OD



Conclusions:

- **A proven ARO field joint coating exists for HDD applications**
- CFR 192 - “Precautions should be taken” for HDD coating selection = Composite ARO solutions
- CSA Z662 Clause 9.2.2 “Particular Attention”
- add Australian Standards
- 10-15X better fracture toughness than the current solutions
- Safe, fast and easy installation
- Fast curing (~30 minutes)
- Non-shielding
- Excellent track record
- Cost effective – excellent insurance policy to protect the anti-corrosion coating when CP protection may be an unknown after the pipe is installed.

Questions

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Thank You

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HDD/BORING – THE REAL COST

October 10, 2022

HDD / BORING - THE REAL COST

- **Soil conditions**
  - Will the coating survive pull back?
  - What is the cost of re-pulling?
  - What is the cost to abandon the pipe?
- **Will anomalies be found?**
- **Spot repairs**
  - Will spot repairs be possible?
- **How much will re-pull and repair cost if it fails?**

CASE STUDY: COST OF 3800’ RE-PULL
20” OD PIPE VS. Composite Wrap Preventative Option

Oklahoma Onshore Project - 2016

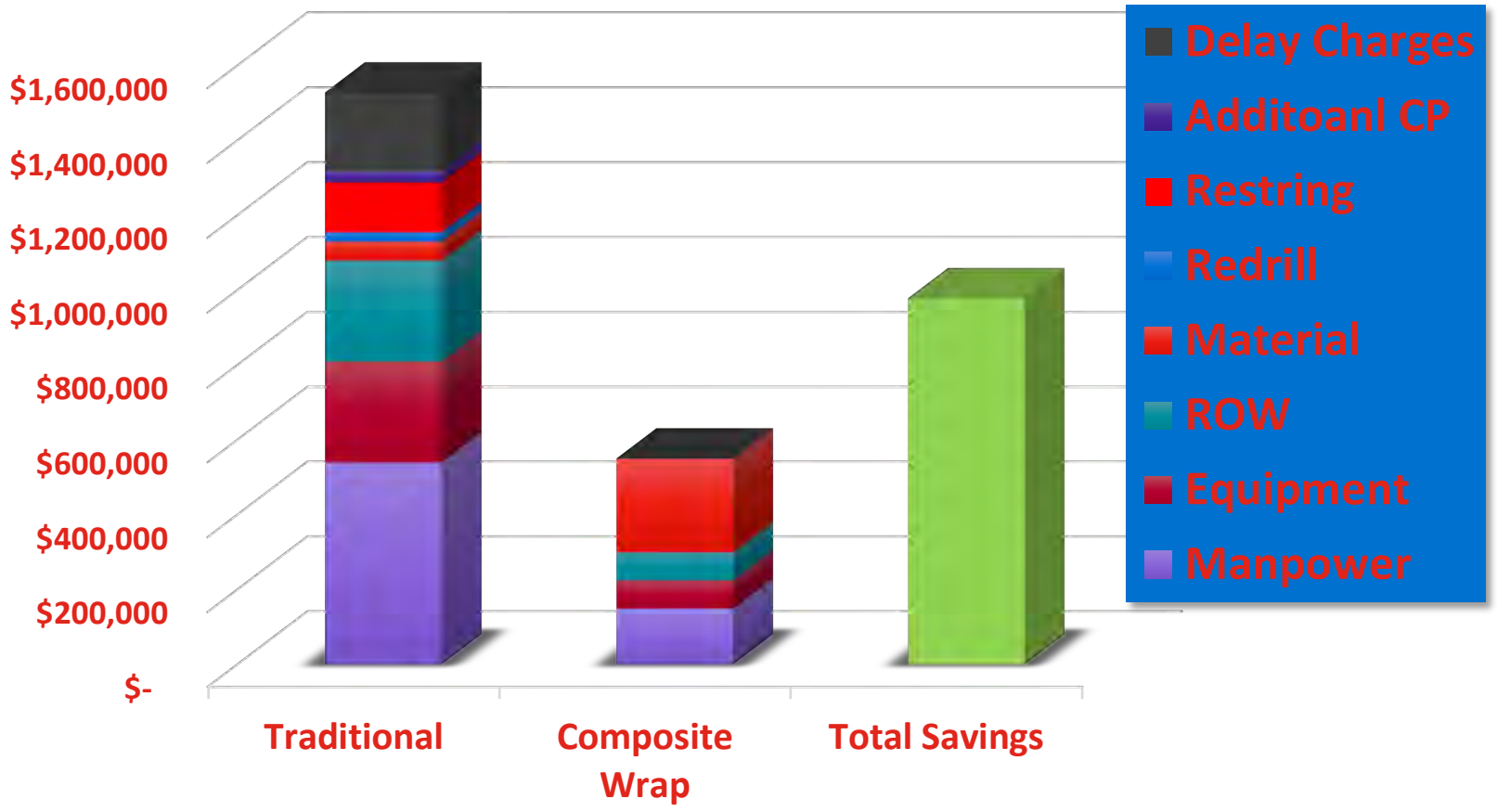
- After HDD, contractor observed FBE coating was significantly damaged
- Gouges along the length and removal of coating over the weld peaks.
- HDD pullback had to be repeated



CASE STUDY: COST OF 3800’ RE-PULL

20” OD PIPE VS. Composite Wrap Preventative Option

Oklahoma Onshore Project - 2016



CASE STUDY: COST OF 3800’ RE-PULL
20” OD PIPE VS. Composite Wrap Preventative Option

Oklahoma Onshore Project - 2016

- The repair costs for the 3,800’ long pull was an additional **US$1,528,000**
- Manpower, Equipment, RoW, Materials, Re-Drill, Re-String, Additional CP and Delay Charges

Why risk it?

Composite Wrap Preventative Option adds a certainty of performance in harsh conditions