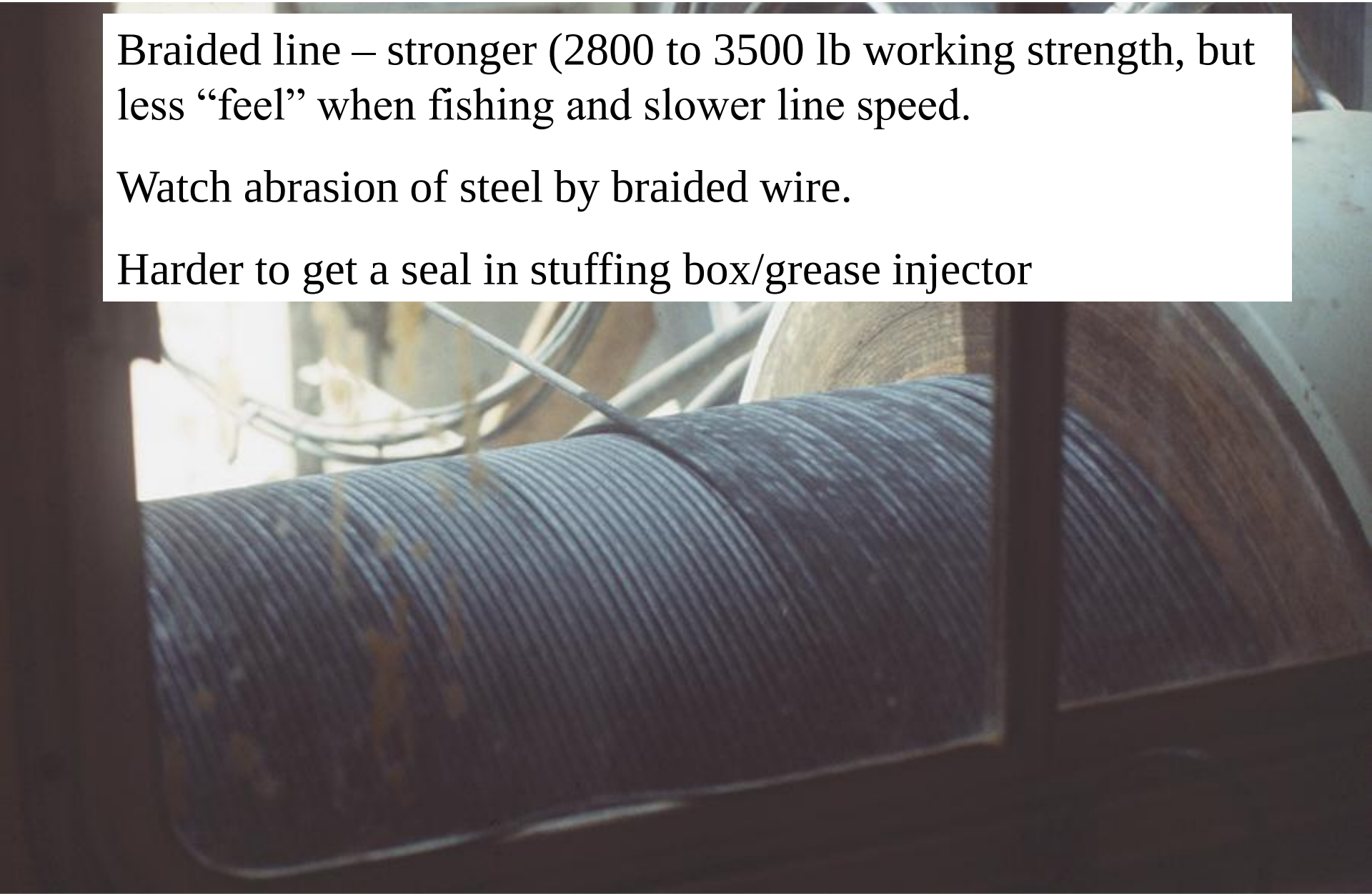
E-Line and Braided Line

- E-Line
- Open Hole wireline

Braided Line

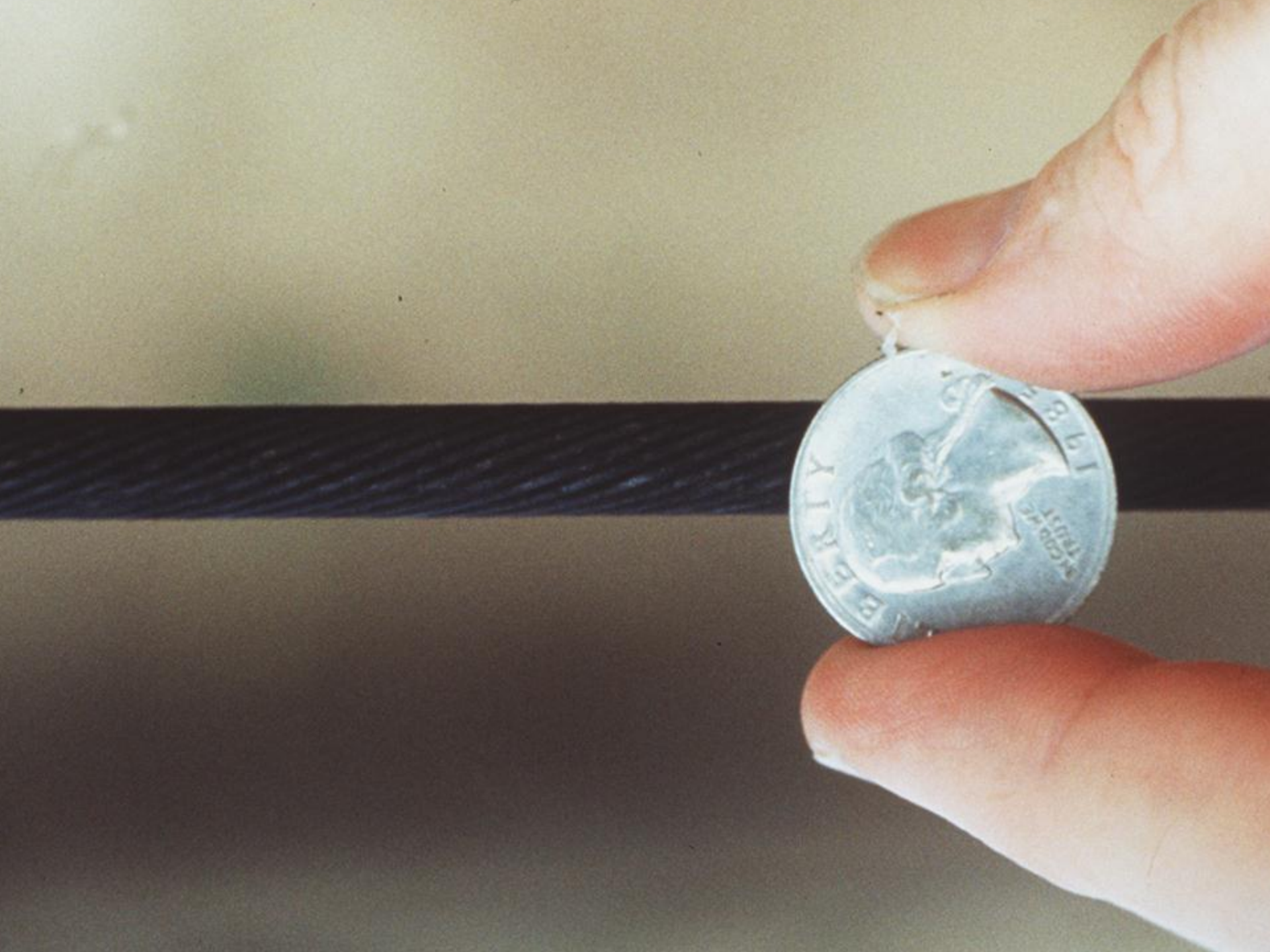
- More strength
- Less “feel”
- Harder to seal
- Much harder to fish



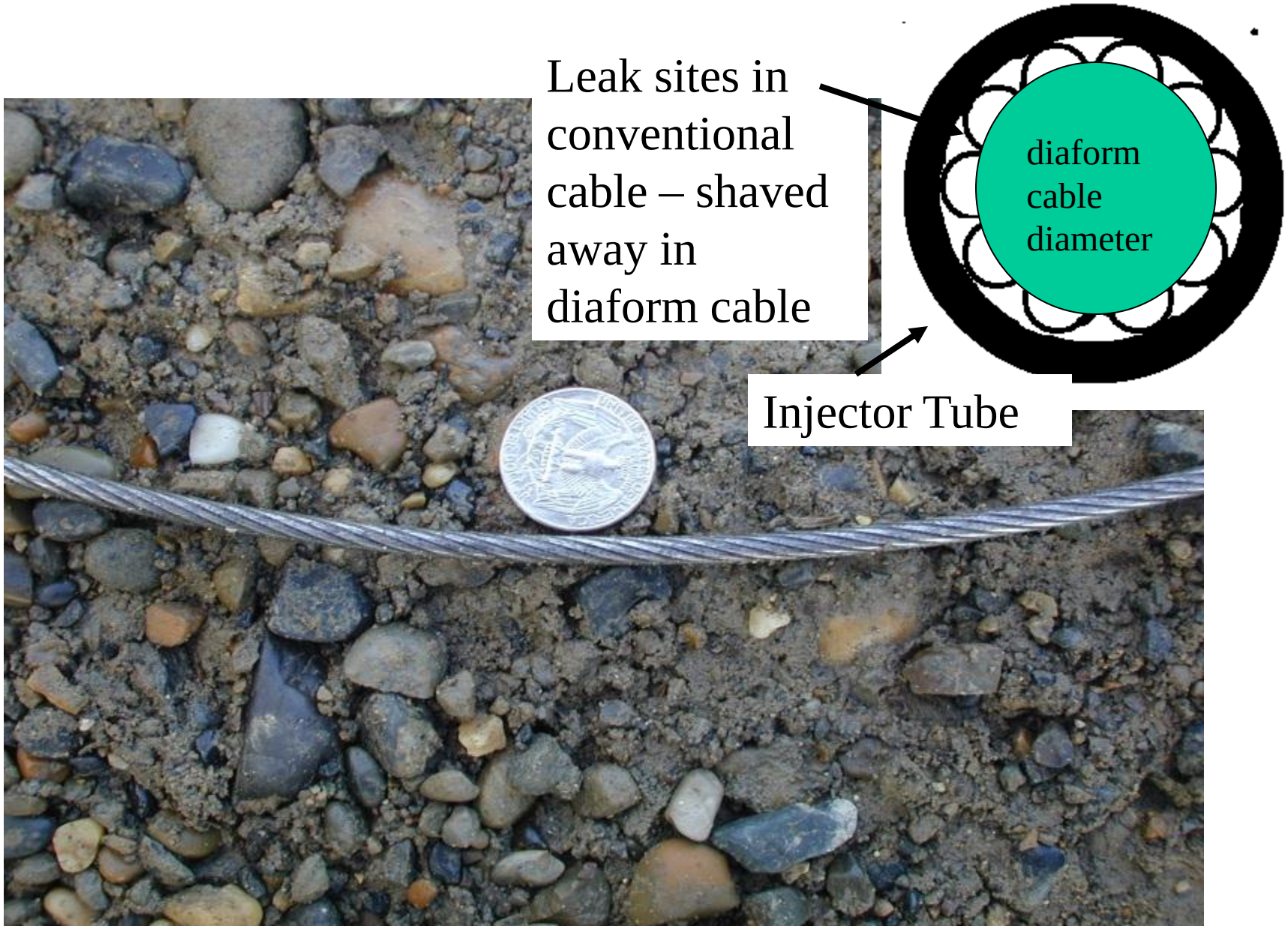
Braided line – stronger (2800 to 3500 lb working strength, but less “feel” when fishing and slower line speed.

Watch abrasion of steel by braided wire.

Harder to get a seal in stuffing box/grease injector


LIBERTY
1961

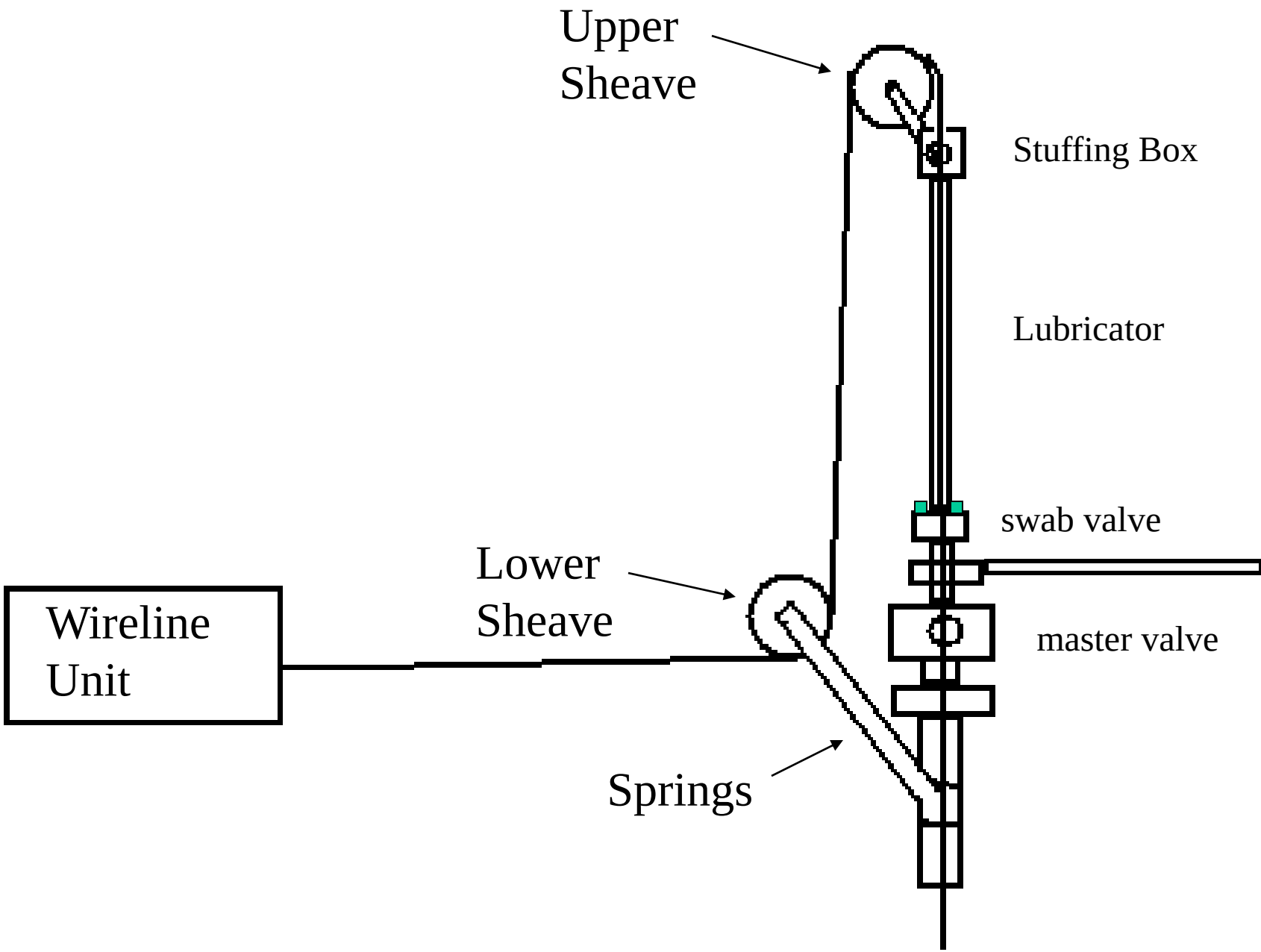
3/16” diaform braided cable. The cable was originally 7/32” and the rounded outside cable edges were removed to improve sealing.



Braided Cable Breaking and Working Strengths

E-Line Size	Type Use	Breaking Strength lbs.	Maximum Working Tension, lbs.
0.23"	Cased Hole	5,800	2,900
3/8"	Cased Hole	13,500	6,750
0.46"	Open Hole	16,700	8,350
0.46"	Open Hole	20,000	10,000

Typical Wireline Rig-up

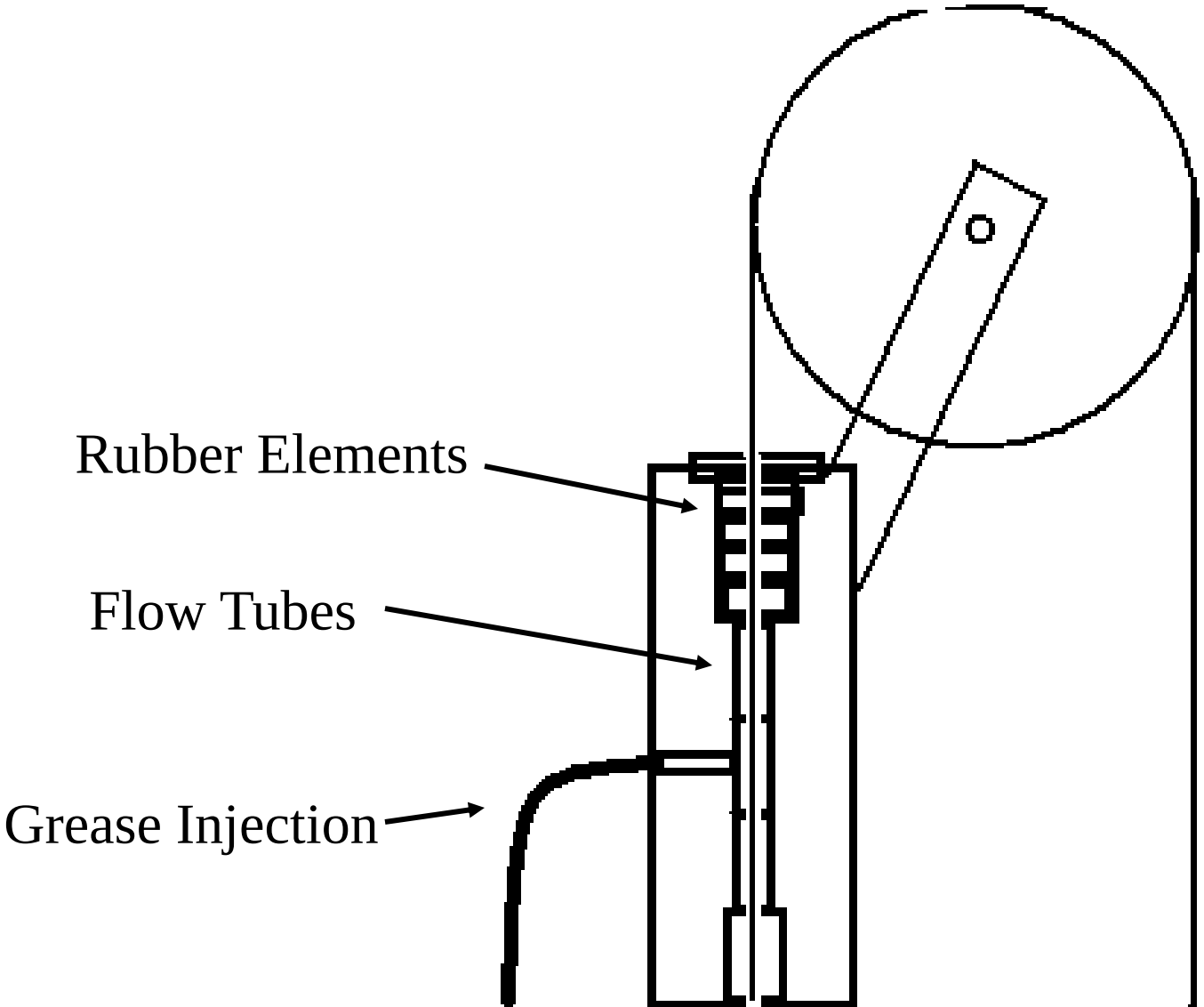


Lubricator Layout and Loading – wireline operations

Lubricator Length

- “Consider the tool string length when sizing the lubricator length. The available length to swallow a tool string is from the top of the swab valve to the bottom of the flowtubes. This length should be the TOTAL tool length, line head to bottom nose, plus 3 extra feet.”

Schematic of a Grease Injector



Packoff

- Line wiper and pack-off assemblies operate by compressing a fluted bored rubber between the E-line and assembly housing.
- Pack-off seals directly above the flow tubes are primarily used to seal stationary E-line in an emergency situation.
- The line wiper, situated above the pack off, is pressured to force the rubber against the E-line wiping excess grease into the void between the wiper and pack off - the grease is returned down a flow hose for collection.

Comments

- If there is friction drag on the E-line from the rubber, the tool string may not have sufficient weight to enter the well.
- As the wiper rubber wears, the pump pressure required to wipe the line will be greater, but should never exceed 500 psi., particularly on new E-line.

Testing Grease Injector

- Close the packoff and apply grease pressure to the flow tubes at 125% wellhead pressure. Check ALL valves on the system to be sure they are closed and install pressure gauges as required.
- If OK, release the packoff and carefully RIH.
- NEVER RIH without first testing the total system at the jobsite.

Braided Line Grease Injector

- **Blowing grease in the air? - the rubber is worn out.**
- **Loosing grease in the well? -flow tubes too big/worn, braided line worn. Either way, too much clearance.**
- **Number of tubes depends on the pressure. Bottom flow tube must be close to diameter of braided line.**
- **If grease use is high (over 10 lb/day) operator may be pumping too much grease - more than needed.**
- **Greases comes in different viscosities, formulated for pressure and temperature combinations .**
- **If hanging gauges in well on braided cable during a job, do not pump grease - just tighten rubbers.**
- **Some greases thicken and/or emulsify with well or injected fluids. Formation damage can be severe.**

Braided Line Size Uses

- 0.23" E-line is typically used for higher pressure jobs such as production logging, neutron logging, perforating, etc.
- 3/8”" E-line is used for running tools requiring multi-conductors such as cement bond logs, oriented whipstock setting and inflatable bridge plugs.

Pressure Suggestions

- Well surface pressure must be less than 1500 psi. to obtain an effective seal on 3/8” line and at pressures over 1000 psi.
- Line speeds must be slowed and flowtubes tight to keep a seal.
- 0.23” E-line can operate at 3500 psi. and higher without problem if flowtubes have been properly sized and correct temperature range grease is used.

Open Hole Wireline

- 0.46” or open hole E-line is 7 electrical conductor wire in heavy or standard strength.
- This size line is not used for pressure work
  - difficult to maintain a seal around it
  - may be spliced.

Braided Line Damage Methods

- **Insulator conductor** package damage will occur if more than, 3500 lb., 60% of the E-line breaking strength is pulled.
- **Wire strand damage** will occur if more than 4350 lb., 75% of the breaking strength of the E-line is pulled.
- **E-line crush** at the drum flange is common if the RIH weight of the E-line is less than 25% of the POOH weight while operating around maximum pulls

Braided Line Damage Methods

- **Bird caging** occurs when running into the well with lower tension above the E-line than below it,
  - E-line is run into the hole faster than the fall of the tool.
  - the pack-off is too tight.
  - in high GOR wells where gas jetting may occur. In such wells, the E-line should not be left stationary where it may be exposed to a gas jet.

Braided Line Damage Methods

- **“Milking” the E-line** usually occurs when the line wiper or pack-off assemblies are over pressured when pulling out of hole to a point where the E-line is squeezed, forcing a severe reduction in diameter which loosens the strands. The loose strands will be in the well where they can not be seen.
- Too tight fitting flowtubes can have a similar effect when RIH but the loose strands will be above the pack-off and readily seen.

Braided Line Damage Methods

- **Kinked or bent E-line** usually occurs when there is no weight on the line, such as RIH too fast, and is one of the most common occurrences.
- **Repairs** The loose strand problem can be repaired, in the cable shop, by running the line on and off the drum under controlled conditions. Minor kinks can be taken out. Broken strands can be shimmed or soldered but the line can not be used with flowtubes again. Openhole E-line is commonly spliced without problem.

Seasoning Braided Line

- New E-line from the manufacturer will require “seasoning,” which consists of:
  - using flow tubes on the high side of the tolerance,
  - running into the well for 1000 feet, at a low speed, 5000 FPH, and pulling back out slowly, 2000 FPH, for 500 feet. This may vary depending on depth deviation and or local procedure. This is repeated every 1000 feet all the way to bottom.
  - After 5 runs to bottom the line is usually seasoned and smaller flowtubes can be used. This is a time consuming procedure but is necessary in order to prolong the E-line useful life.

Positioning the E-Line Unit

- When spotting the E-line unit, consideration should be given to maximizing the distance between the lead sheave and the E-line drum.
- To achieve the optimum spooling performance, the distance from the lead sheave to the E-line drum should be at least twenty-five times the width of the E-line drum or greater which will ensure a Fleet Angle of less than 1.25°.
- The Fleet Angle is the angle between the E-line and the line from the center of the bottom

Seasoning Braided Line

- During this procedure, torque in the armor wires is balanced, the E-line diameter reduces and the length increases.
- Excessive pressure on the line with the pack-off or line wiper should be avoided at all costs as this will deform or milk the E-line, damaging it beyond repair.
- The armor will seat-in less on each subsequent run until the length increase is minimal but during the first few runs it should be monitored closely for open strands or high wires.

Depth Control

- There are two independent electronic depth systems on E-line units.
- The units check each other and sound a warning if a preset difference is detected.
- Electronic depth systems should agree with the data acquisition depth system and should be checked by turning a known number of turns on the measure wheel for the correct value of depth.
- The measure wheels should be kept clean and free of debris, asphaltenes, wax or ice. Wheel slippage is a common problem in

Safe Braided Line Working Tension

- A rule of thumb for safe working tension is 50% of the E-line breaking strength

or

- a tension which results in a 50% pull on the weak point pull-out, whichever is less.

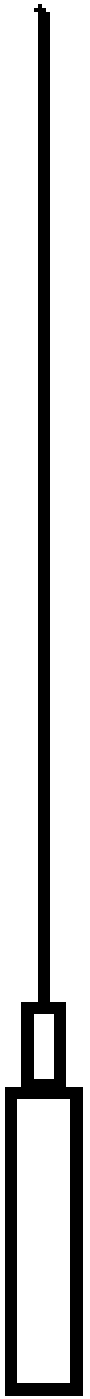
Above this point, a wireline supervisor should be informed.

Safe Braided Line Working Tension

- Working tension is normally calculated as a pull on the weak point value plus tension from E-line weight and drag in a free tool (not stuck) situation.
- Calculating reference values of tension as amount of over-pull allows the winch operator at any depth to instantly sum his known up weight at that depth, plus the reference value, to provide a maximum pull weight indicator reading.

Example

- Assuming:
  - tool weight (tw) of 202 lbs.,
  - an “up” tension of 1777 lbs., and
  - a weak point (wp) built for a 1272 lbs. pull out.
- Pull out = wp - tw = 1272 - 202 = **1070 lbs**.
- To release at depth we would pull up weight + 1070 = 1777 + 1070 = **2847 lbs**
  (surface wt reading)



Tension at surface 1777

Release built for 1272 lb

Tool weight 202 lb

Working Tension

- **50% value = (weak point x 0.5) - tool weight) = (1272 x .5) - 202) = 434 lbs.**
- **To pull 50% at depth = pull up weight + 434 = 1777 + 434 = 2211 lbs.**

Building a Rope Socket

- On E-line operations the outer and inner armor is used to join the E-line to the rope socket assembly and set a pullout tension. This pullout tension is generated by multiplying an evenly distributed number of armor wires, locked into the rope socket assembly, by the breaking strength of the outer armor.
- When using a E-line package with inner and outer armor of the same diameter, use of inner armor in the re-head assembly may contribute to the pullout weight. In this case

Considerations for Calculating Wire Strength and Weak Points

1. New wire values are used in calculations, thus, as the outer armor wears, the quantity of strands calculated may need to be increased.
2. Empirical testing shows that on a properly constructed weak point, with even distribution of the selected armor on new cable, there is a variance of up to ± 12%.
3. Well bore temperature decreases armor wire strength by 2% at 100, 8% at 200, 10% at 250 and 12% at 350 degrees Fahrenheit.

Example for 0.23” Wire

- Given:
  - 15,000 feet deep well, 30 degrees deviation,
  - gas filled casing,
  - 4000 psi. surface pressure
  - tool weight of 150 lbs.
- Calculate:
  - required string weight and
  - E-line head weak-point strength.

Example

- The E-line weight in air is 95 lbs. per 1000 feet.
- Buoyancy is normally ignored (especially in a gas filled hole).
- Max E-line weight = 15 x 95 = 1425 lbs.

Example

- Drag on the tool string is usually small (and usually ignored), however, drag on the E-line should always be considered since it increases with depth, deviation and well direction.
- Drag best guess wireline drag estimate = 150 lbs.
- Required tool string weight for 4000 psi. WHP is calculated using a factor of 0.038 pounds sinker bar weight per well head psi. plus ≈50 pounds to overcome grease injector friction.
- Minimum tool string weight = (4000 x 0.038) +

Example

- The rule of thumb ,where possible, is to choose a weak point that will allow the maximum pull on the cable to be within the manufacturers working specification which, for this E-line is 2,900 lbs.
- To calculate the maximum available pull we subtract the sum of the drag plus the E-line weight from the working specification.
- Maximum available pull out within working spec. = 2900 - (1425 + 150) = 1325 lbs

Example

- The weak point is only 100 lbs. over tool string weight which means that the 2900 lbs. working specification will be passed in order to provide a safe working weak point
- If 50% of the E-line breaking strength is used, there will still be a 550 lbs safety margin before conductor/insulation yield is reached.
- Maximum available pull out to 50% breaking strength = 2900 - (1425 + 150) = 1325 lbs.

Number of Strands

- Each armor strand in the 0.23” wire has a break strength of 212 lbs.
- Number of strands to be used = available weight divided by 212 (round up to nearest whole strand).
- When complete, sum the pull-out, plus E-line weight, plus drag. Ensure it is less than conductor/insulation yield by an acceptable factor.
- Number of armor strands = 1325 / 212 = 6.25 (7 strands)
- Pull to conductor/insulator yield = 3500 - (6 x

Problems

- If the assembly sticks at 15,000 feet and the initial drag estimate was not great enough the conductor/insulation yield can easily be reached or passed.
- **Pull of greater than 3500 lb. (60%) on the 0.23” E-line should never occur** but if it is necessary, due to operational problems, all supervisors should be made aware, permission should be given by the asset owner and safety procedures followed.

Electrical Problems

- Problems with insulation and continuity are usually found the E-line to head connection. Temperature swings (freeze/thaw cycles often cause problems)
- The E-line itself is extremely durable and problem free.