

TDR vs. OTDR – GENERAL INFORMATION

TDR functions on the principle that a disturbance within a field can be detected by the reflections provided by the disturbance. For example, coaxial cable is commonly utilized for TDR (time domain reflectometry). An electrical pulse is generated and transmitted down the cable. If any changes are encountered along the cable that affect the transmission characteristics of the pulse, a reflection is generated at this boundary. The reflection passes backwards up the cable to the pulsing/detection device. The time elapsed since the transmission of the pulse is recorded, allowing a distance to the reflective event to be calculated. Characteristics of the reflection assist in determining the nature of the field disturbance. Light transmitted in fiber optic cables can be utilized in a similar fashion.

For rock/soil deflection multiple bends or kinks can be detected within cables installed in drillholes, allowing precise location of dislocation zones or planes. In addition, its digital nature allows real time monitoring of the subsurface as the data can be continually transmitted to a computer conducting analyses. It is relatively inexpensive in terms of monitoring probes. Disadvantages are that relatively minor shear may cause the cable to fail and that only a limited estimate is obtained of the magnitude of displacement. However, the area above the failure within the drillhole continues to function as a monitor, allowing continuous monitoring as the failure progresses towards surface.

The major differences between optical and coaxial TDR are:

- Range - coaxial TDR, while potentially practical up to 20000 ft, is limited in accuracy at this distance. Distances of about 2000 ft/600m appear to be the maximum practical monitoring limit due to cable effects. This includes trunk lines on surface as well as the downhole monitoring probe. Longer cables can be utilized, however, by increasing the pulse voltage. Changes in the pulse shape and duration upon transmission downline, especially after encountering any kinks or bends will reduce accuracy. Optical TDR can theoretically be utilized at distances up to 25 miles/40km and beyond. As for coaxial cable, accuracy decreases as a function of cable length. However, indicator crimps or bends in the line can be utilized as reference markers, increasing local system accuracy;
- Redundancy - multiple fiber cables can be installed in a single hole at little extra cost. This is not true for coaxial cable, where one cable is generally the limit;
- Flexibility - fiber optic cable is very flexible and has potentially greater use in softer materials, especially with our patented anchor system as described under innovations on this site;
- Survivability - armored fiber optic cable is extremely durable and will survive severe impact and abrasion. Once again, coaxial is less resistant to such damage and, for large diameter cable, is much more difficult to lay. Water leakage/pressure is also a problem with coaxial systems. If a foam dielectric is utilized, the buried end of the cable must be sealed against water intrusion. Upon cable shear, this seal is lost and water can intrude upon the dielectric space;
- Cost – coaxial cable TDR is cheaper for short range monitoring and a limited number of points. For long range monitoring, a large number of points, or a centralized monitoring system, optical TDR appears to have the economic advantage;
- Sensitivity – both systems can be extremely sensitive to displacement. Straight glass fiber is less sensitive to kink deflection but allows less lateral travel before being cut by shear displacement. This is both a plus and a minus as it provides a positive node where shear occurred but does not allow as much flexibility of seeing beyond a local shear point, such as is capable with coaxial cable.

The solid rod fiber optic system as shown under innovations will fail at around 1-2mm of lateral displacement. This should function even in soft soils.