The Development of a New Super-Tough Cable Jacket

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SYNOPSIS

The harsh environment to which underground cables are exposed requires the best protection available. Presently the number of economical options available to the system designer is limited.

This paper introduces a new jacket design especially designed to protect sensitive coaxial cables from damage due to impact, abrasion and mechanical fatigue. Design development and testing of the new cable vs conventional cable designs are discussed within the paper.

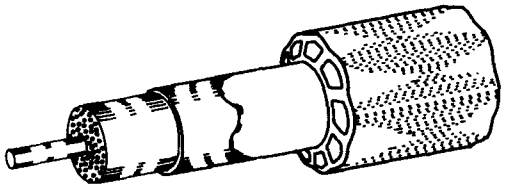
INTRODUCTION

For many years the cable industry has relied on telephone invention and research as a basis for its design. This reliance includes the use of steel armored cables for improved enviromental protection during installation and the life of the cable. Steel armored cables provide good crush resistance, rodent resistance and low frequency shielding. Unfortunately, steel armored cables are very expensive and somewhat over engineered for certain uses in the CATV applications. Many CATV cables require crush and corrosion resistance but often do not require rodent protection or low frequency shielding afforded by steel tape.

Presently the CATV operator has three expensive options available to him if he requires additional cable protection; armored cables, cable in conduit, or trench and backfill. A new cable jacket design offers an alternative to these options.

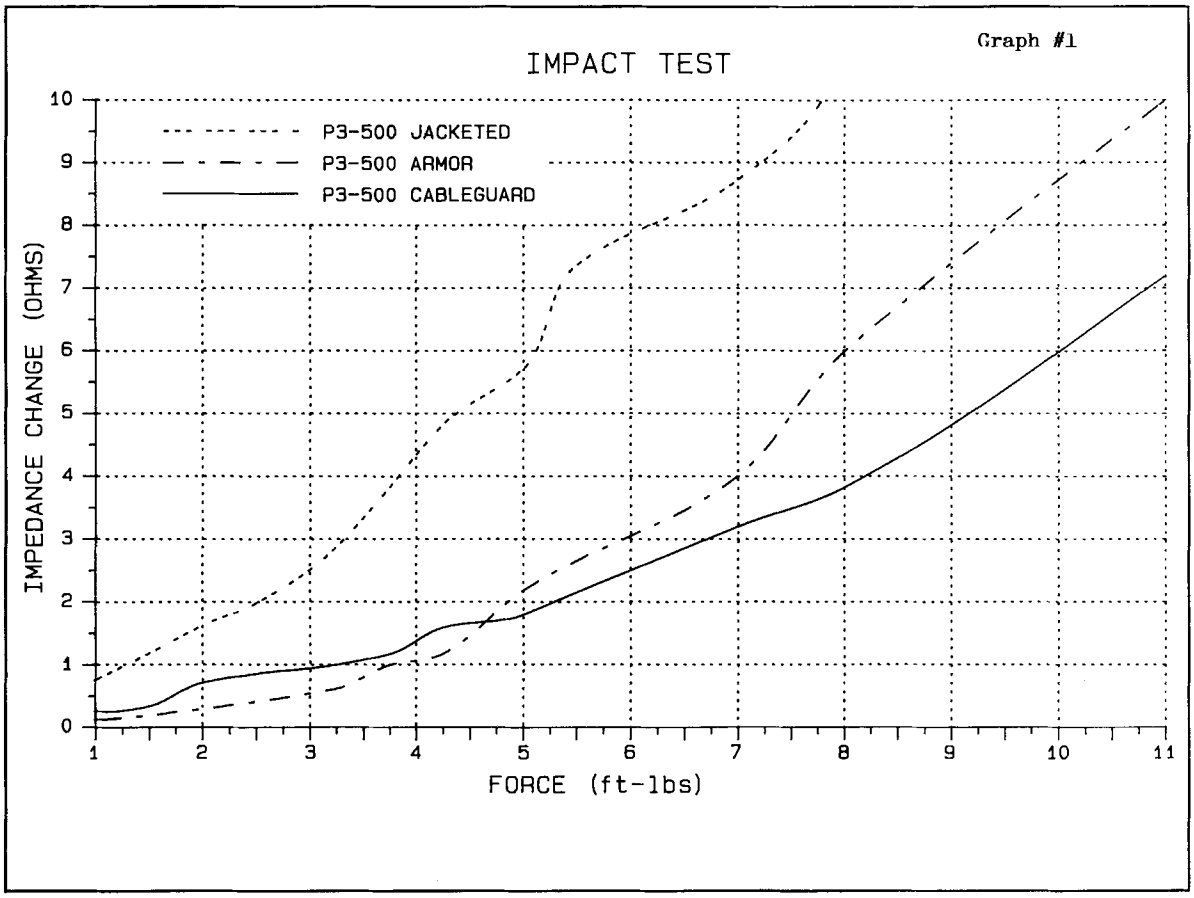
It is possible to provide a level of crush and impact resistance nearly equal to armored cables but at a significantly lower cost. The new jacket incorporates air cells surrounded by layers of Linear Medium Density Polyethylene (See Drawing #1). The air cells act as a cushion to dampen the forces applied directly to the cable conductors. The ridges that make up the cells provide an effective barrier reducing cut through and impact damage much the same as the flutes provide with corrugated packaging.

CABLEGUARD™ Drawing #1



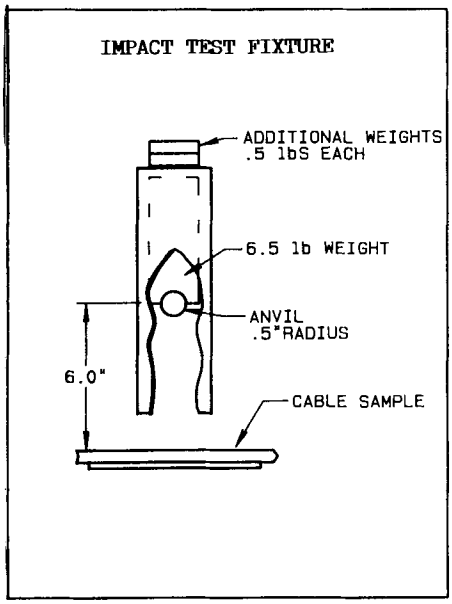
JACKET DESIGN

The new jacket design, called Cableguard™ was first conceived in early 1986 but only after numerous product designs and process modifications was the product available for commercial evaluation in January 1987. Upon close examination of the jacket design one sees the utilization of arches that provide support to the outer jacket. By modifying the classic arch, setting the arch at an angle one can modify the direction and magnitude of the forces directly applied to the inner foundation of the jacket. By connecting the arches together and tieing the bases of each arch together the load or impact can be more evenly distributed over a larger area. With conventional jackets and armored cables the ability to withstand impact is primarily affected by the rigidity of the individual components of the cable. With conventional jacket, once the cylindrical polyethylene jacket is deflected the majority of the force of impact is directly transmitted to the outer conductor of the cable. With armored cables the rigidity of the jacket and armor provides an effective barrier of impact up to a point but once this impact force is exceeded all additional impact force is directly transmitted to the outer sheath of the cable. Graph #1 displays the effect of impact on various designs of cable jackets.



As can be seen the conventional cable jacket provides limited impact protection. The armored cable provides a much higher level of protection but as higher forces are applied the % change in impedance vs impact in foot pounds increases significantly. At low impact the Cableguard™ jacket behaves much like armored but with high impact forces the slope of the curve is more gradual. This difference can be justified by understanding how the individual cells are deflected. As the impact force increases the more the arches tend to fold or collapse absorbing and distributing the force not only around the cable but perpendicular to the point of impact. Finite Elemental Analysis reveals for a given impact applied to the Cableguard™ sample up to 65% of the force applied to the outer jacket is discipated before reaching the outer conductor of the cable. The analysis also reveals for conventional jacketed cable 95% of the impact applied to the jacket is transmitted to the outer conductor of the cable (See Drawings #2 and #3)

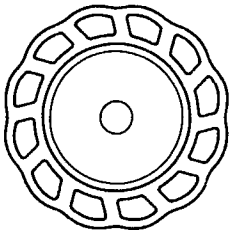
While Cableguard™ was designed for impact resistance, armored cables still out perform Cableguard™ in static compression test. Graph #2 compares the performance of various cable designs under static load.



Drawing #2

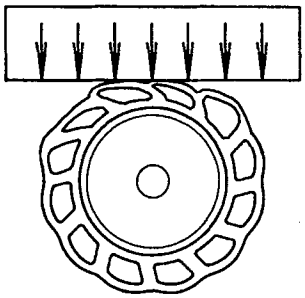
MATERIAL: MEDIUM DENSITY POLYETHYLENE

DIMENSIONALS: OUTER JACKET 30mils THK.
INNER JACKET 30mils THK.
WEBS 50mils THK. 75mils HIGH



NORMAL CELL STRUCTURE

APPLIED LOAD

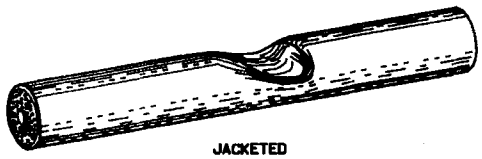


CELL DEFORMATION
UNDER LOAD

Drawing #3

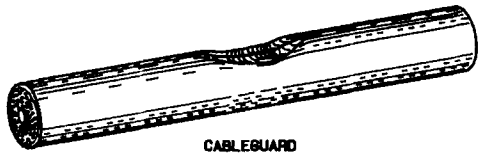
IMPACT TEST RESULTS

BOTH CABLES RECIEVED THE SAME IMPACT FORCE



JACKETED

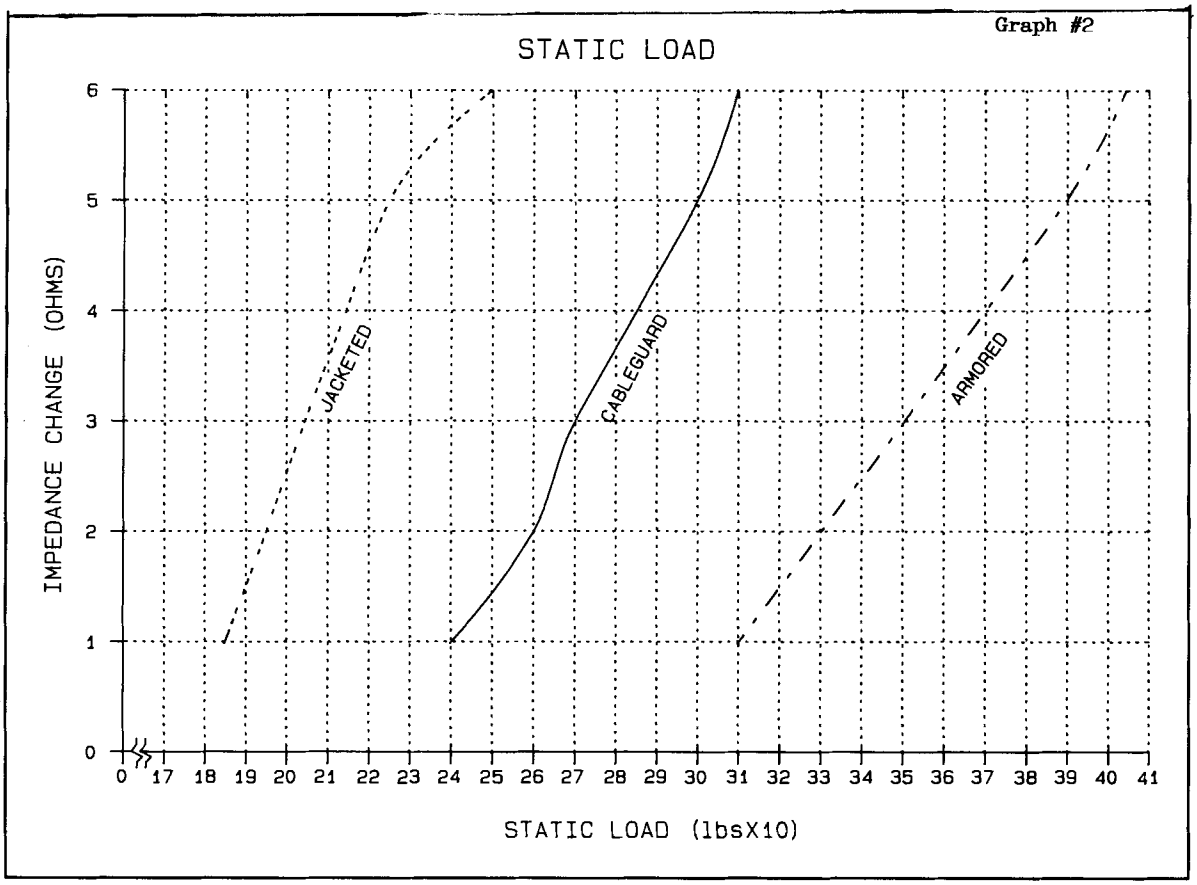
AFTER REMOVING THE JACKET, IT IS APPARENT THAT THE JACKET TRANSFERS THE FORCE OF THE IMPACT TO THE ALUMINUM SHEATH.



CABLEGUARD

AFTER REMOVING THE JACKET, IT CAN BE SEEN THAT THE CABLEGUARD JACKET ABSORBS THE MAJORITY OF THE IMPACT BY DISTRIBUTING THE FORCE ALONG THE INTERNAL JACKET RIBS.

Graph #2



PERFORMANCE COMPARISION:

	500 Standard Jacket (Medium Density PE)	500 Armored Jacket (2 Medium Density PE Jacket Plus .006 Steel Tape)	500 Cableguard™ (2 Medium Density PE Jackets With Air Cells)
Impact Test Impedance Change @ 5 ft/lbs.	5.7 ohms	2.2 ohms	1.8 ohms
Impact Test Impedance Change @ 10 ft/lbs.	14.0 ohms	9.3 ohms	6.0 ohms
Minimum Bend Radius	8.0"	10.5"	8.0"
Direct Burial Approved	YES	NO	YES
Cut Through (lbs. required to cut through to jacket (drop test)	37 lbs.	160 lbs	110 lbs.
Prep Time (jacket removal with tool)	1 minute	5 minutes	1 minute
Relative Cost (armored equals 100%)	56%	100%	75.%
Typical Diameter	.600	.730	.750
Compression (static crush test 3 ohm change)	205 lbs.	350 lbs.	270 lbs.

STANDARD JACKET

Advantages:

1. Good corrosion protection
2. Ease of connectorization (jacket removal)
3. Low cost
4. Product can be plowed or trenched in the ground
5. Light weight
6. Small bend radius

Disadvantages:

1. Poor cut through resistance
2. Low impact resistance
3. Does not improve crush or deformation resistance (susceptible to deformation in plow during installation)

ARMORED JACKET

Advantages:

1. Good corrosion protection
2. Excellent cut through resistance
3. Good crush and deformation resistance

Disadvantages:

1. High cost
2. Difficult to remove jacket for connectorization
3. Requires trench installation technique (often can not be plowed)
4. Heavy product to handle
5. Larger bend radius

CABLEGUARD™ JACKET

Advantages:

1. Good cut through protection
2. Excellent crush resistance
3. Moderate cost
4. Ease of connectorization (jacket removal)
5. Light weight
6. Small bend radius
7. Product can be plowed

Disadvantages:

1. Require jacket stripping tool
2. Air cells must be sealed at shrink boot
3. Diameter much larger than standard jacket

CONCLUSION

New jacket designs for coaxial cables will provide an added level of protection to the cable. While Cableguard™ does not perform as well as armored cables the various advantages and disadvantages of each should be considered. Armored cables should always be used for locations with rodent problems or severe abrasive components in the soil. Cableguard™ type jackets should be considered where fear of abrasion, mild cuts or crush resistance is a factor.

Hopefully, the evolution of jacket materials and jacket designs will allow simplication of installation and improve the service life for coaxial cables.

ACKNOWLEDGEMENTS

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