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SESSION
WORKSHOP NOTES

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"Ruggedize or Rust - Bridge Submarine Cable", Matt Bodziony,
BIW Cable Systems, Ma.

RUGGEDIZE OR RUST
BRIDGE SUBMARINE CABLES

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ABSTRACT

A bridge submarine cable's primary function is to deliver electrical power, signal or optical transmission across a body of water. Bridge submarine cables employ coverings that provide long term mechanical protection of the cable core after installation. Ruggedized cables employing heavy armor are essential in shallow water environments to protect the cable from hazards that do not arise with land cables buried in solid earth. These include corrosion by water, abrasion against rocks, movement due to sand erosion, direct damage by ship's anchors, and any fallen objects. Additionally, the steel covering (normally galvanized steel wires) provides mechanical protection and strength for the cable core while handling during installation. Several protective coverings have been designed to accomplish these goals, each employing galvanized steel wire armor. Direct exposure of the steel wires to water will cause accelerated corrosion or rust. It is therefore of prime importance to protect the steel wires from the surrounding water throughout the projected life span.

This paper discusses four common types of protective coverings employed on the galvanized steel wire armor for bridge submarine cables. All designs use a jacketed inner subcomponent. Their associated advantages and disadvantages regarding long term corrosion protection and installation will be considered. The designed life for an underwater environment is discussed for each cable type without consideration of price.

INTRODUCTION

The first galvanized steel wire armored submarine cable was manufactured in the year 1851 for the crossing of the English Channel between England and France. In the previous year (1850), an unarmored cable was installed and lasted less than one year when it was severed by a fisherman's anchor. This prompted the addition of galvanized steel wire armor over an electrical core which significantly extended the life of the cable. Since 1851, the use of galvanized steel wire armor to protect permanently installed electrical underwater cables has continued until our day.

Several goals became apparent regarding the use of galvanized steel wire armor and their coverings:

- Good abrasion resistance during and after installation.
- Provide strength during installation.
- To limit the ingress of water into the armor area if the covering becomes punctured while under water.

Coverings employed over the steel wire armor are designed to protect the armor from corrosion due to water ingress. Migration of water into an unprotected steel wire armor area will cause accelerated corrosion and eventual loss of the original mechanical protection.

The use of tarred jute over and under the galvanized steel wire armor as a corrosion protection has become a standard within the industry. Current ICEA (NEMA) and British standards specify a tarred jute finish for submarine cables.

In recent years (1960's) the development of weather resistant thermoplastic materials has promoted various combinations of galvanized steel wires with thermoplastic coverings. These newer constructions do not necessarily improve the performance of the cable.

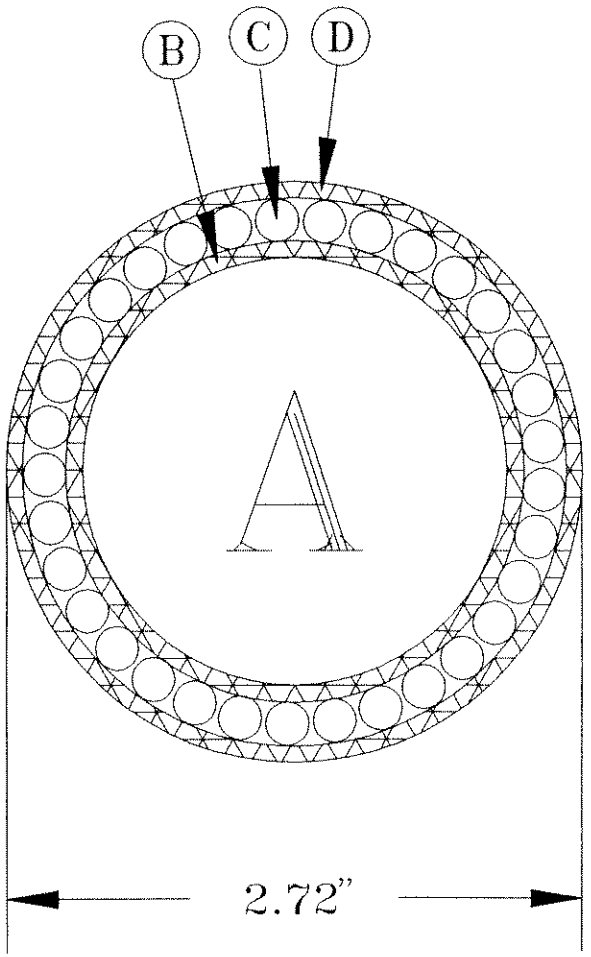
TYPE I
JUTE/STEEL WIRES/JUTE

This type of armor corrosion protection is illustrated in figure 1. The combination of jute with tar/asphalt is an excellent corrosion inhibitor in an underwater environment. This covering limits the ingress of water directly onto the steel wires. Since the steel wires are saturated with the tar/asphalt, any occurrence of external damage throughout the life of the cable will cause minimal corrosion of the affected steel wires.

The overall jute layer itself provides limited mechanical protection. It's primary function is to contain the tar/asphalt material on the armor. The inner jute layer provides a bedding for the armor and acts as a retainer of tar/asphalt for the underside of the steel wires. With this arrangement the steel wires provide maximum physical protection with approximately 95% coverage of the electrical core.

Removal of the jute outer layer during terminating is relatively simple since it can be unwound by hand.

FIGURE 1



TYPE I

JUTE/STEEL WIRES/JUTE

A – Jacketed Electrical Core

B – Asphalt Impregnated Jute Layer

C – BWG Galvanized Steel Wires

D – Asphalt Impregnated Jute Layer

NOTE: Asphalt applied over B,C, & D

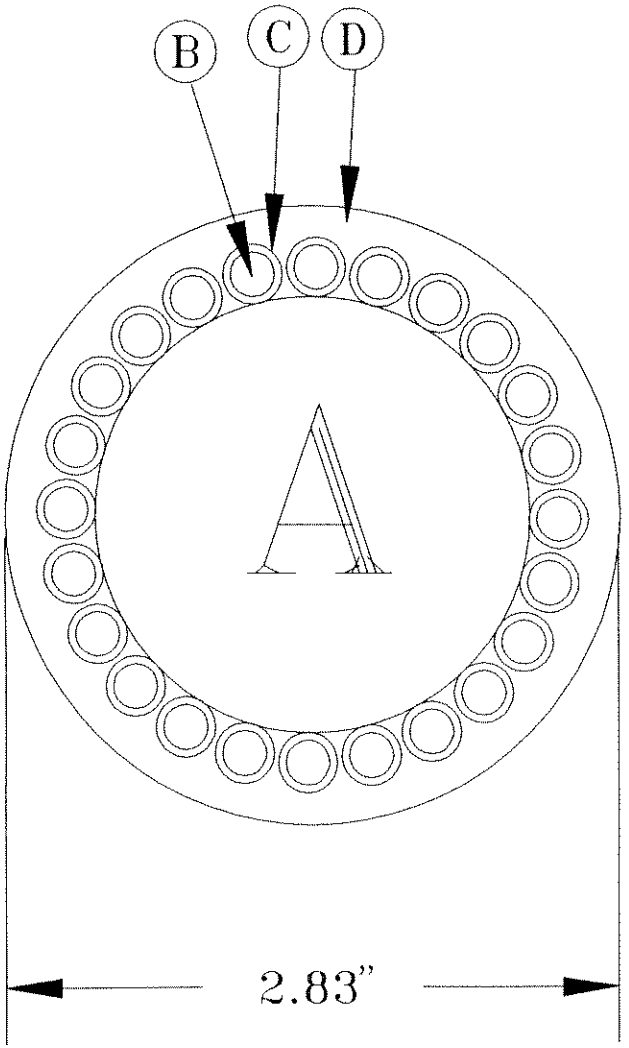
TYPE II
PLASTIC COVERED STEEL WIRES/PLASTIC OVERALL JACKET

This type of armor corrosion protection is illustrated in figure 2. The use of plastic over bridge submarine cable steel wires began in the 1960's. The covering over each individual steel wire and the overall jacket is normally high density polyethylene (HDPE) or polyvinyl chloride (PVC). HDPE is preferred due to it's superior low moisture absorption properties and good penetration resistance (especially to sharp objects). Installation of HDPE jacketed cables may be easier since the jacket will slide relatively easily over surfaces when compared to PVC. This is due to the lower coefficient of friction for HDPE vs. PVC. Since HDPE causes the cables to be somewhat rigid when compared to PVC, the installer would have to consider whether this would cause any difficulties. The overall jacket helps to prevent the armor wires from unlaying during installation and rounds out the cable to provide a smooth overall finish. This covering combination causes the overall cable diameter to be the largest, yet the second lightest in weight of the four types of constructions.

This construction provides good corrosion protection for the armor since any external damage throughout the life of the cable will cause minimal corrosion of the affected steel wires. With this arrangement, the steel wires provide good physical protection with approximately 70% coverage of the electrical core. For any object to penetrate between the steel wires, it would have to be as thin as .080" and be able to penetrate through the plastic jacket and individual steel wire coverings. This would be very unlikely.

Removal of the overall plastic jacket is the most difficult of the four types of coverings. Since the jacket is extruded and fills the outer interstices of the covered steel armor wires, additional effort is required to cut and remove the jacket. Some adhesion may exist between the plastic jacket and the plastic coverings over each wire.

FIGURE 2



TYPE II

PLASTIC COVERED STEEL WIRES/ PLASTIC OVERALL JACKET

A – Jacketed Electrical Core

B – BWG Galvanized Steel Wires

C – Plastic coating on wire

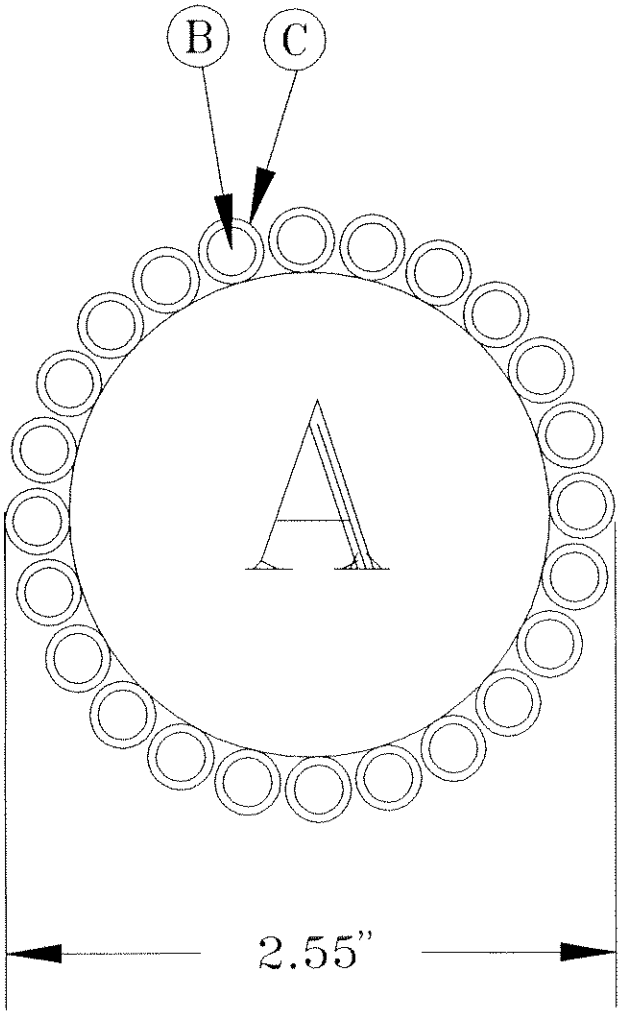
D – Plastic Overall Jacket

TYPE III
PLASTIC COVERED STEEL WIRES

This type of armor corrosion protection is illustrated in figure 3. This design is very similar to Type II with the exception that the outer plastic jacket has been eliminated. The individual wires that are covered with plastic (HDPE or PVC) provide limited mechanical protection during installation and subsequent operation. Since the outer surface is uneven, a possibility of snagging on an object during installation is more likely than with an overall smooth construction. Any loading during installation could cause the armor wires to unwind and loosen.

The corrosion protection for the armor is not considered as ruggedized as Types I and II. Without an overall covering, the jacketed armor wires are more prone to experience damage. With this arrangement, steel wires provide good physical protection with approximately 70% coverage of the electrical core. However, a sharp object only has to penetrate through the steel wire coverings to reach the core. The covered wires may even move aside to allow a larger gap for an object to penetrate.

FIGURE 3



TYPE III

PLASTIC COVERED STEEL WIRES

A – Jacketed Electrical Core

B – BWG Galvanized Steel Wires

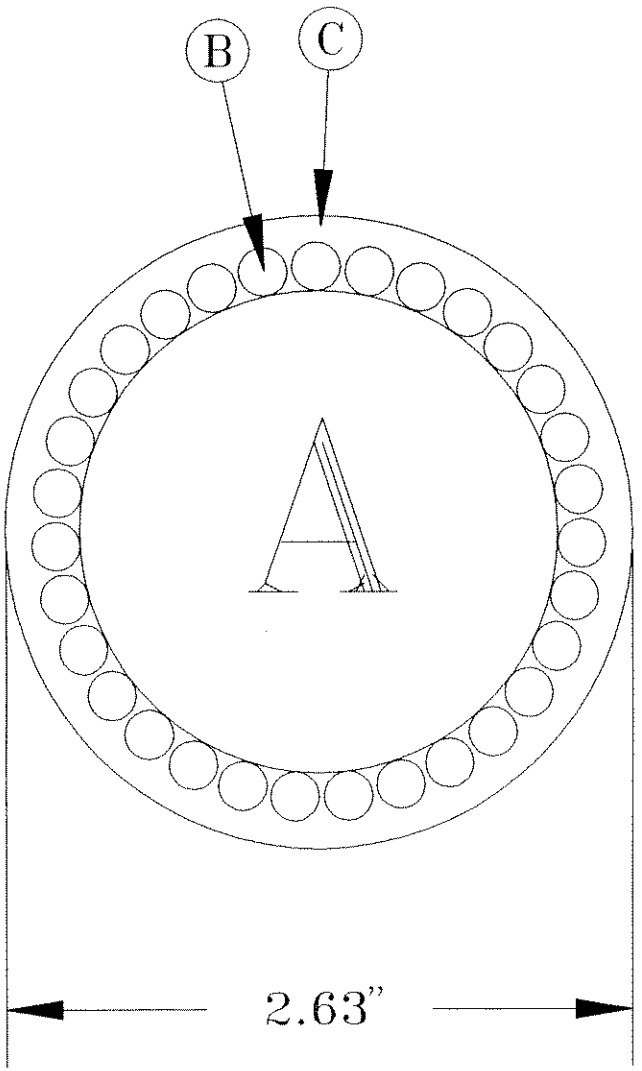
C – Plastic coating on wire

TYPE IV
STEEL WIRES/PLASTIC OVERALL JACKET

This type of armor corrosion protection is illustrated in figure 4. In this construction the primary barrier between the water and the steel wires is the plastic overall jacket. Extra care must be exerted during installation not to puncture the overall jacket. Since no additional protection exists over each individual wire, any ingress of water into the armor area will allow it to surround all the steel wires. Accelerated corrosion will occur and reduce the cable's mechanical protection.

With this arrangement, the steel wires provide maximum physical protection with approximately 95% coverage of the electrical core. The overall jacket helps to prevent the armor wires from unlaying during installation and round out the cable to provide a smooth overall finish. While the construction appears to be sound, a punctured jacket which is discovered after installation in the water will cause the cables's mechanical protection to deteriorate rapidly. Even if the cable is removed, it is extremely difficult to repair the jacket with the armor area flooded with water.

FIGURE 4



TYPE IV

STEEL WIRES/ PLASTIC OVERALL JACKET

A – Jacketed Electrical Core

B – BWG Galvanized Steel Wires

C – Plastic Overall Jacket

CONCLUSION

For long term corrosion protection, types I and II appear to be superior to types III and IV. This is primarily due to the combination of individual corrosion protection surrounding each steel wire plus an overall covering.

Type I (jute/steel wires/jute) coverings have existed and proven themselves effective for over 100 years. Their successful long term corrosion resistance is based on maintaining the tar/asphalt saturant around each steel wire. Damage of the jute covering would not necessarily cause significant steel wire corrosion since the tar/asphalt coating will continue to protect the individual wires.

Type II (plastic covered steel wires/plastic overall jacket) coverings have existed and proven themselves effective for approximately 25 years. Their successful long term corrosion resistance is based on maintaining the plastic coverings over each wire. The overall plastic jacket serves as a binder to prevent unlaying of the armor wires during installation, and gives additional protection for the individual steel wire coverings.

Type III (plastic covered steel wires) coverings have also existed and proven themselves effective for approximately 25 years under certain conditions. While each steel wire is covered with plastic, providing a degree of corrosion resistance, this covering is more susceptible to damage during and after installation. This construction may be employed in certain underwater environments with careful installation practices.

Type IV (steel wires/plastic overall jacket) coverings have existed and proven themselves effective for approximately 25 years under certain conditions. The type of covering is the most likely to lose total corrosion protection since the overall jacket is relied upon as the only water barrier for all the steel wires. Penetration of the overall jacket occurring during or after installation will allow accelerated corrosion of the steel wires to occur. As with type III coverings, this construction may be employed in certain underwater environments with careful installation practices.

REFERENCE

C.C. Barnes, "Submarine Telecommunication and Power Cables", 1977