ELEVATOR TRAVELING CABLE - DESIGN EVOLUTION

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ABSTRACT
The requirements of the elevator traveling cable have changed significantly over the past 25 years. This chapter takes a look at modern traveling cable and the different product designs available to the contractor. Utilizing the best design and the proper application method for specific applications is also discussed.

INTRODUCTION

The elevator traveling cable is a vital link between the elevator car and the controller. In conventional elevators all power and signal information travels through the traveling cable. The vast majority, as much as 95%, of wire and cable produced today will be installed in a fixed location. The remaining product will be used in an application where some degree of motion is required. Many of these cables are easily replaceable and no serious consequence may result from their failure, such as: portable appliances and portable tools. The remaining flexible cables which are in motion during service are expected to last a long time, such as: mining cables, oil well boring cables, crane cables, and elevator traveling cables. The elevator traveling cable is a very specialized multi-conductor cable which is continually in motion and must last for many years. A generally accepted life span is 20 years which is equivalent to 3,000,000 flex cycles. Here we will review the installation and application of the elevator traveling cable and the different products available to the elevator contractor.

INSTALLATION

The traveling cable is typically mounted in the elevator hoistway where each end is terminated and alternately takes the full load of the suspended cable as the car moves up and down. The hoistway termination may be in a mid hoistway junction point as seen in Figure 1 or in the machine room itself as seen in Figure 2.

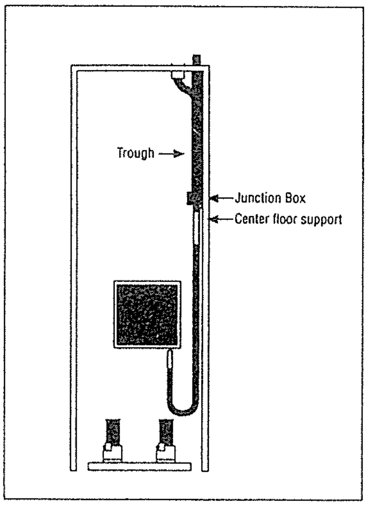

Figure 1 - Mid-Hoistway Attachment

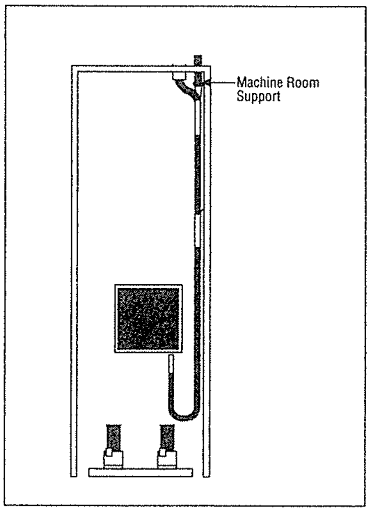

Figure 2 - Machine Room Attachment

By terminating the traveling cable in the machine room, the labor required to make electrical connections in the junction box is eliminated. The resulting longer length of traveling cable may be more susceptible to trailing problems due to building sway and wind. One intermediate installation technique being used today is to terminate the traveling cable at the hoistway midpoint using the steel support member or by some other means and continue to run the traveling cable to the machine room as shown in Figure 3. This technique eliminates the labor required for mid hoistway electrical terminations and also restricts the cable length that is free hanging.

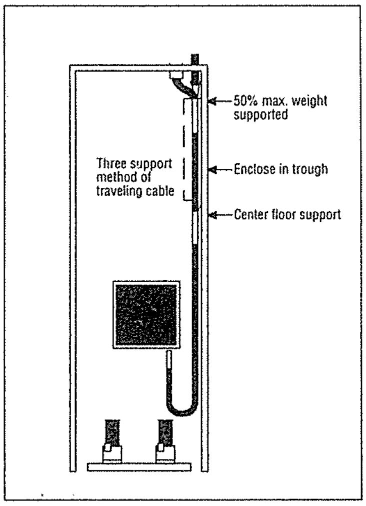

Figure 3 - Three Point Suspension

The three methods for terminating the traveling cable are by an integral support member, a self tightening device, or by looping the cable around a bar or spool and tying it to itself. Most electrical codes and standards require a suspended length of traveling cable exceeding 60 meters to be supported by an integral support member which is most commonly a flexible steel strand. This is accomplished by wrapping the steel strand around a spool and clamping it back to itself as shown below for round cable in Figure 4 and for flat cable in Figure 5.

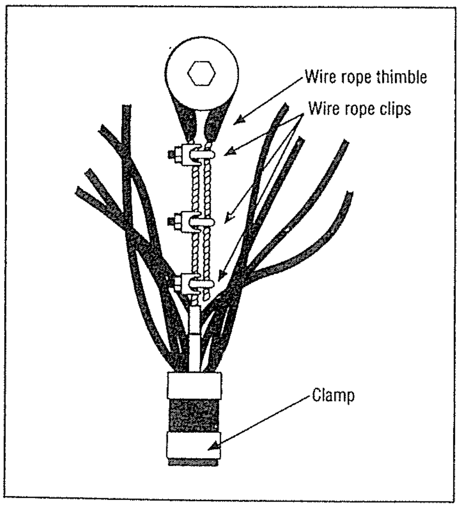

Figure 4: Support Steel Termination - Round Cable

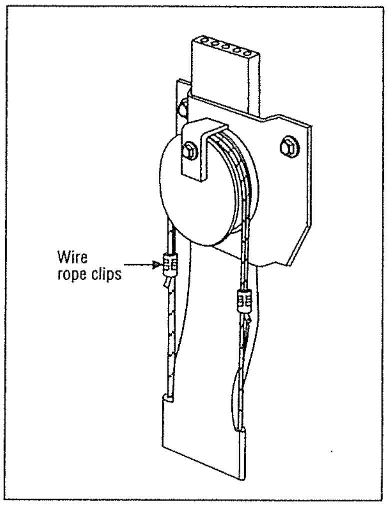

Figure 5: Support Steel Termination - Flat Cable

Another device being used today consists of an overall bracket for securing the cable with an integral self tightening device for the steel support member as shown in Figure 6.

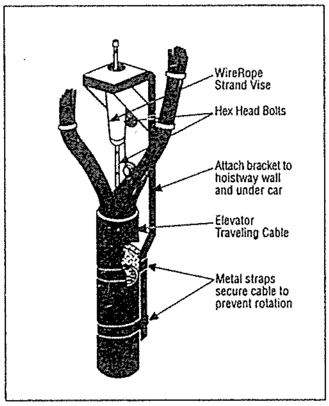

Figure 6 - Overall Bracket for Cable Termination

Of all the steel core termination methods, the steel core hanging device is the simplest to install. The hanger construction allows the wire rope to be inserted into the strand vise from only one direction without allowing the rope to slip or pull out. Neither wrenches nor bending of the wire rope is required. The strand vise automatically tightens itself on the wire rope for a secure termination. The wire rope strand vise is widely accepted in the field for its ease of installation and reliability.

The support bracket is designed to provide additional stability for the elevator traveling cable. The strand vise is inserted through the top flange to support the cable weight. The metal bracket extends down and is formed to cradle the cable below the strand vise support. Metal straps secure the cable to the bracket for improved lateral and rotational cable stability. With both cable ends secured, the cable can act as a cohesive unit during installation and operation underload.

Self-tightening devices are generally used to support cables not requiring a support member. This would typically be for cables with a suspended length of less than 60 meters. Self-tightening mesh grips are the most common termination means for round cable suspension as shown in Figure 7. Wedge clamps are the most common termination means for flat cable as shown in Figure 8.

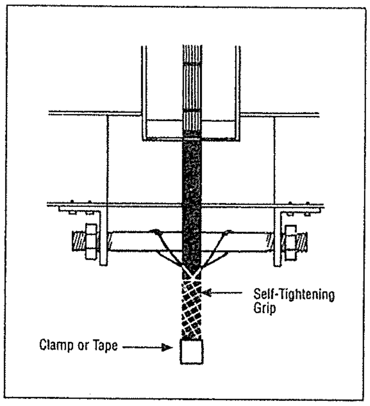

Figure 7 - Self-Tightening Mesh Grip

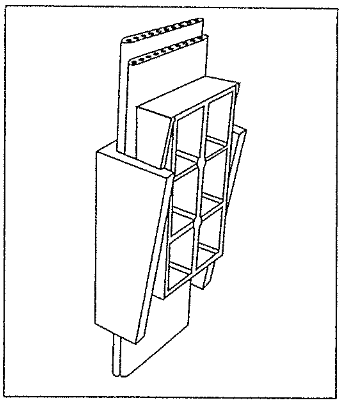

Figure 8 - Self-Tightening Wedge Clamp

Looping the cable around a support bar or spool is allowed by some codes and continues to be used in the industry for cables without a support member. This is the most unsatisfactory method for cable installation.

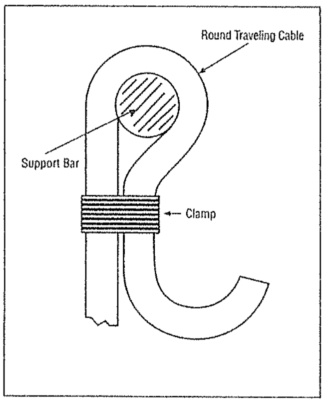

Figure 9-Round Cable Loop Termination

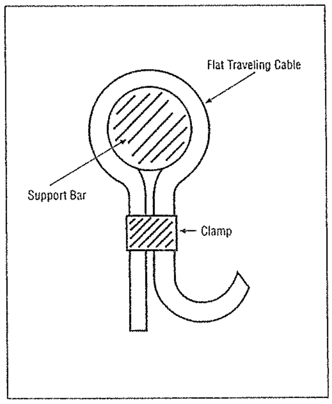

Figure 10-Flat Cable Loop Termination

The severe bends as shown in Figure 9 and Figure 10 in this type of installation may cause stress points in the copper conductors which will eventually work-harden and break as the cable undergoes cyclic loading.

DESIGN CONSIDERATIONS

Some of the considerations in the design of the elevator traveling cable are cable strength, flexibility, torsional balance, abrasion resistance, flame resistance, and low temperature performance. The cable must be so designed that there is little strain of the copper conductors. One of the primary means of limiting this strain is by the use of the steel support member. The steel support is commonly used as a center support member in a round cable and as integral support members in a flat construction. In flat constructions the support may be either embedded in the plastic coating or as the support member of a group of insulated conductors.

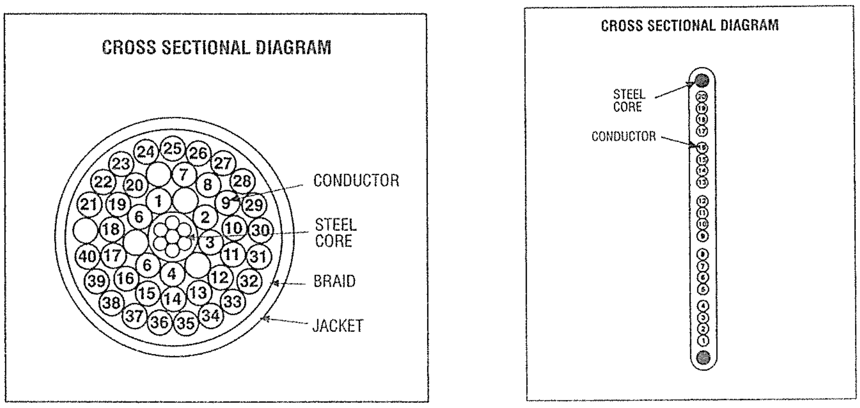

Figure 11 - Support Members in Round & Flat Cable

Flexibility of the cable is achieved by the selection of the materials used in the cable and also by how the cable is constructed. The copper conductors used in elevator traveling cables are of a highly flexible construction. For instance a .75mm^2 conductor is actually constructed of 30 strands of .18mm diameter wire. The materials used to insulate the wires and to overcoat the completed cable are formulated to aid in the flexibility of the completed product. Just as important are the construction techniques used to assemble the completed cable whether it is round or flat.

Torsional balance is the tendency of a cable to untwist or turn under load and to re-form into its original position when the load is removed. As an elevator rises, the cable section nearest the car attachment point is exposed to greater and greater loads until, when the car is at the upper most point, the car end of the cable is under maximum load. At this point the hoistway end of the cable is under its minimum load. Cables with torsion generate vibration during travel; when the vibration becomes great, a danger develops due to problems such as the cables becoming tangled and the cables becoming severed by contacting with the wall, the rail, or the car. As the elevator hoistway has become small in recent elevator constructions due to economizing, and the space between the car and the wall is narrow, minimizing the vibration is very important. In order to minimize the torsion effect of this loading and unloading, manufacturing techniques are used in both the manufacture of round and flat cables. One such technique is the alternating of the stranding direction in each layer of a multi-layered round cable. Similarly, in some flat cable constructions containing stranded units, the units are alternately stranded in opposite directions.

Abrasion resistance, flame resistance, and low temperature performance are primarily addressed through the materials used for insulating and jacketing the cable. Polyvinyl chloride is a widely used thermoplastic which has relatively good performance in these three areas and is a cost effective material. When special performance characteristics are required, then other polymers may be used for a specific applications. In some cases where extraordinary abrasion resistance is needed, an outside coating of polyurethane has proven effective. In some municipal jobs, halogen-containing materials are banned requiring special polyolifin compounds to be used in manufacturing the traveling cable.

PRODUCT DESIGNS

The traveling cable required for the sophisticated elevators of today does not closely resemble the cables of 25 years ago. The older cables contained perhaps 20 or 30 conductors of 16 AWG or 1mm^2. Today's cables might contain a variety of wire sizes and components for specific purposes. A typical cable (Figure 12) will have 14 AWG (1.5mm^2) conductors for constant current carrying circuits, 18 AWG (.75mm^2) conductors for signaling circuits, 20 AWG (.5mm^2) conductors with shielding for telecommunications circuits and data circuits, and perhaps a coaxial cable for closed circuit television. In some cases, fiber optic components are being used for video and data transmission. An optical fiber's immunity to electrical and electromagnetic interference allows for the transmission of high quality signals to and from the elevator car.

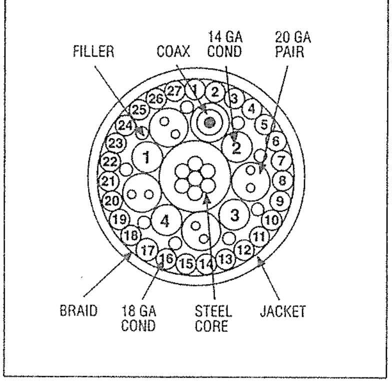

Figure 12 - Typical Composite Cable Construction

The two basic types of traveling cable which have already been mentioned are the round configuration and the flat configuration. The round cable is typically made up of several layers of insulated conductors or components stranded around a central member. Round cables can contain quite a large number of conductors, sometimes as many as 120. The round construction also offers great flexibility with regard to number and size of components. A variation of the round cable is what is referred to as a rope lay or unitized construction. This cable is manufactured by building a number of small round cable cores and then putting those cores together to form one larger cable. This construction has particular advantages in some special situations. For instance, it has a relatively small loop and could be used in space constricted areas. Strength components can be added to the small unit cores, giving the finished cable increased overall strengths which may be required if the cable travels over a sheave or is exposed to some other extreme mechanical condition.

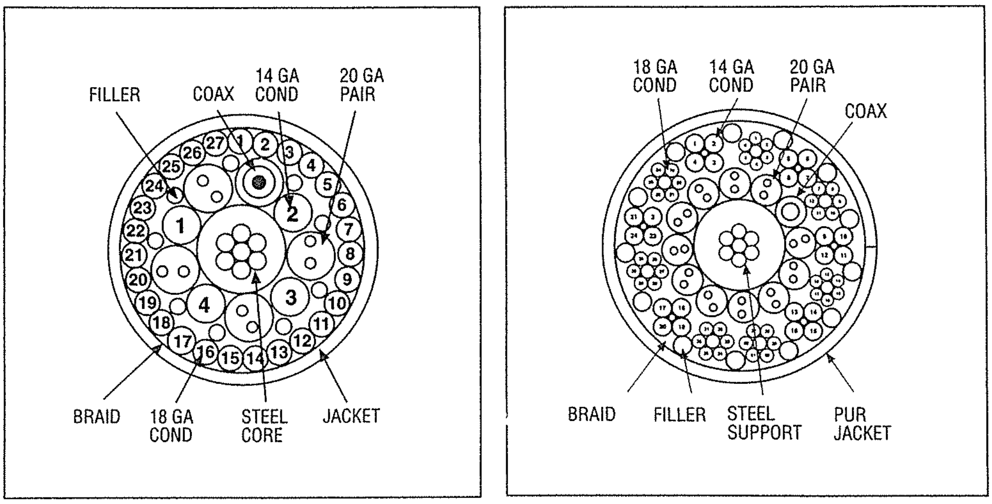

Figure 13 - Conventional Round vs. Rope Lay Construction

Flat cables can generally be classified as either parallel flat or unitized flat. The parallel flat is constructed by laying conductors and/or components side by side and applying an overall jacket or sheath. The unitized flat cable is constructed by laying small round cable cores (as in the rope lay construction) in parallel and covering with an overall sheath or jacket.

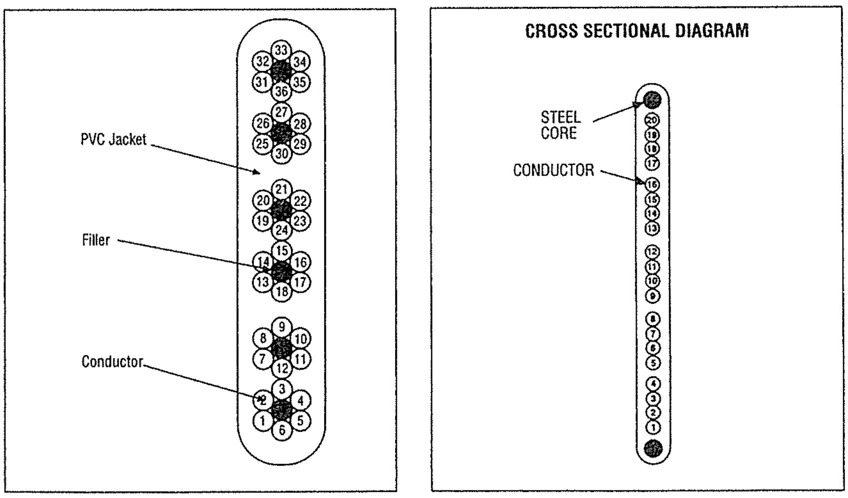

Figure 14 - Flat Cable Constructions - Parallel and Unitized

FLAT OR ROUND

There has been much discussion concerning the advantages of the round cable vs the flat cable and vice versa. Much of the ongoing discussion revolves around the cost effectiveness of the two constructions with regard to product cost and also installation time required.

The product cost of the parallel flat is less than an equivalent round cable cost when the total number of conductors required for a given unit is low. When multiple flat cables have to be combined to achieve the proper number of conductors, a single round cable becomes more cost effective. The unitized flat construction allows more conductors per flat cable but does not compare favorably with the equivalent round cable product cost. A general idea of product cost compared to total conductors required per unit is shown in Figure 15.

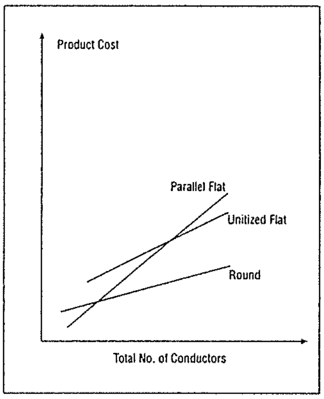

Figure 15 - Product Cost vs. Total Conductors

Performance wise, each of these products serve a need in the market place and in some cases it does become customer preference. One such instance will be if a very small loop is required, then the flat cable might fulfill that special need. If a large number of wires and components are needed, then round cable may be the right choice.

SPECIAL CONSIDERATIONS

Special considerations must be taken into account for the high rise segment of the market. It is these extreme conditions that test the traveling cable to the fullest. In some instances there may be 200 to 250 meters of traveling cable free hanging in the hoistway. These free hanging cables oscillate with building motion and build up large amplitudes. As they pick up energy from oscillation of building movement, they may become entangled with hoistway protrusions or compensation ropes which experience the same phenomena. One solution to this problem has been the installation of a traveling carriage to separate and restrict the movement of both the compensating ropes and traveling cables as seen in Figure 16. This carriage is roped two-to-one to the car and provides a midway restraint and oscillation dampener for the traveling cables and the compensating ropes as seen in Figure 17. The carriage is able to run on the same guide rails as the car and has guides for compensation ropes and traveling cables.

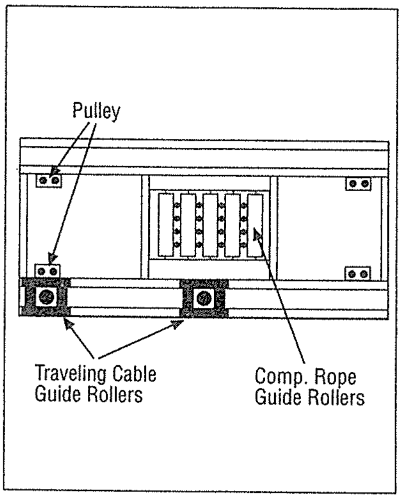

Figure 16 - Top View of Traveling Carriage

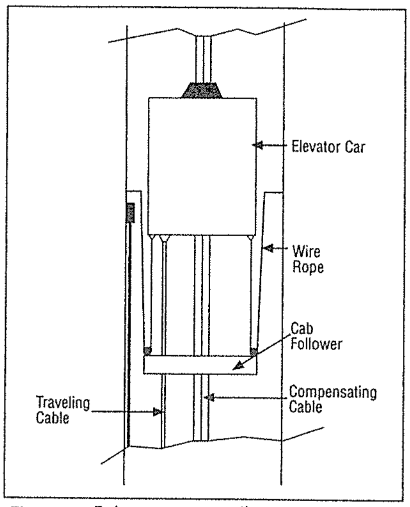

Figure 17 - Traveling Carriage Roping Diagram

CONCLUSION

Quite a number of elevator cable designs and installation techniques are available today. The elevator contractor must work closely with the cable manufacturer's applications engineers to insure the best product for the specific application is being used.

REFERENCES:

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BIOGRAPHY:

Richard Laney is Director of Engineering with Republic Wire and Cable, Siecor Corporation. He has held various engineering positions with Siecor during the past 24 years and has been primarily involved with the manufacture of elevator cable products for the last 17 years. Mr. Laney graduated from The Citadel in 1968 with a B.S. Degree in Electrical Engineering.