

# Chapter 1

## Underground Power Cable Construction

### ABSTRACT

*This chapter deals with many special features of underground power cables. Important points are presented in this chapter. In this chapter the various components of the different underground cables used in transmission and distribution of electric energy are explained. The materials used in the manufacture of these cables are given in details. This chapter also contains the different types of cable joints and terminations.*

### 1.1 CABLES ADVANTAGES AND DRAWBACKS

#### 1.1.1 Cables Advantages

Underground power cables are widely used in transmission and distribution of electrical power, the following are the advantages of underground power cables compared with the overhead transmission lines feeders:

1. They need less space compared to overhead transmission lines (Underground cables need a narrower surrounding strip of about 1–10 meters to install (up to 30 meters for 400 kV cables during construction), whereas an overhead line requires a surrounding strip of about 20–200 meters wide to be kept permanently clear for safety, maintenance and repair).
2. No visual pollution compared with transmission lines in which its insulators exposed to different types of pollution.
3. Less subject to damage from atmospheric activity like wind and lightning as overhead transmission lines.
4. Higher surge impedance reduces severity of switching, lightning and resonance over voltages.
5. Ideal way to transmit power supply to an island.

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### **1.1.2 Cable-Drawbacks**

In spite of the underground cables have many advantages, they have also some drawback. The following are the cables drawbacks:

1. Fault location of underground power cables is difficult and time taking.
2. Underground cables are expensive compared with overhead transmission line feeders (the cost of underground cables is two to four times the cost of an overhead power line at the same voltage level).
3. More monitoring, for certain types of cables, is required.
4. Jointing/termination require persons with high skill levels.
5. Joints/terminations are weak points because the joints and terminations need thicker insulation to reach to the same insulation level of the cable, also the joints are mechanically weak.
6. Testing of underground power cables is difficult and time-consuming.

## **1.2 CABLE CONSTRUCTION**

### **1.2.1 Cable Conductors**

The conductor is the part of a cable carries the load current. The most commonly used materials in conductors are aluminum and copper. The use of aluminum is based mainly on its favorable conductivity-to-weight ratio (the highest of the electrical conductor materials), its ready availability, and the stable low cost of the primary metal. Copper is used in high capacity power cables due to its better conductance. Stranded conductors are used to make the cable more flexible. (Figure 1) gives a sample of stranded conductors' cable. Because moisture has a negative effect on the cable the conductor is made longitudinally watertight with swelling powder or semi conductive filling (Al-Khalidi & Kalam, 2006). Table 1 gives the electrical properties of some metals used in underground power cables. Aluminum wire, which has 61% of the conductivity of copper, has been used in distribution and transmission wiring for its lower cost. By weight, aluminum has higher conductivity than steel, but it has properties that cause problems when used for building wiring. It forms a resistive oxide within connections, causing terminals of wiring devices to heat. Aluminum can "creep", slowly deforming under load, eventually causing device connections to loosen, and also has a different coefficient of thermal expansion compared to the materials used for connections. This accelerates the loosening of connections. These effects can be avoided by using wiring devices approved for use with aluminum. Aluminum wires used for low voltage distribution, such as buried cables and service drops, require use of compatible connectors and installation methods to prevent heating at joints. Aluminum is also the most common metal used in high-voltage transmission lines, in combination with steel as structural reinforcement. Anodized aluminum surfaces are not conductive. This affects the design of electrical enclosures that require the enclosure to be electrically connected

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