

X. Guys and anchors

When a line deadends on a pole or when there is a deviation in the direction of the conductor at a pole, it places a permanent force on the pole. If significant, this force must be counteracted by a guy wire that transfers the force to an anchor in the ground. Guy wires are usually made of stranded steel that is heavily galvanized. However, where guys are near chemical plants or in mining districts, galvanized wire will not stand up, and copper-clad cable may be used under such conditions.

While guy wires are commonly used with conventional medium- and low-voltage lines, mini-grids may use considerably smaller conductor. When this is the case, these smaller conductors can be placed under less tension, and forces which are in turn transferred to the poles at bends or at dead ends are correspondingly smaller and may not require guys to counteract. Furthermore, if ground clearance is more than adequate, lines can have considerable sag, further reducing the tension (see sag-tension relationship, p. 81).

In some countries, guy wire can be useful and tends to “disappear”, placing the system at risk. Therefore, if a guy is essential to ensure the proper operation of the system, all member of the community must be aware of this to avoid tampering or theft. The guy must also be protected vehicles and pedestrians from accidentally running across it.

Strength of cable

Guy on a deadend pole

Fig. 74 illustrates two cases in which guys are used. In the case of a simple deadend at the end of a line (a), the tension in each of the conductors exerts an unbalanced force on the pole. H represents the sum of the horizontal forces on the pole due to the tensions in the two or more conductors. In most cases, this is approximately the same as the sum of the tensions in the conductor. A guy is required to counterbalance this force. However, because the guy is anchored in the ground and makes an angle θ to the horizontal, the tension in the guy is greater than H . It is also increased by a factor SF , a safety factor of perhaps 2. With a total force of H imposed by all the conductors, the guy must be able to resist the force T_g of the following value:

$$T_g = \frac{H \cdot SF}{\cos \theta}$$

The tension in each conductor can be obtained once the sag and weight of that conductor has been established (p. 80).

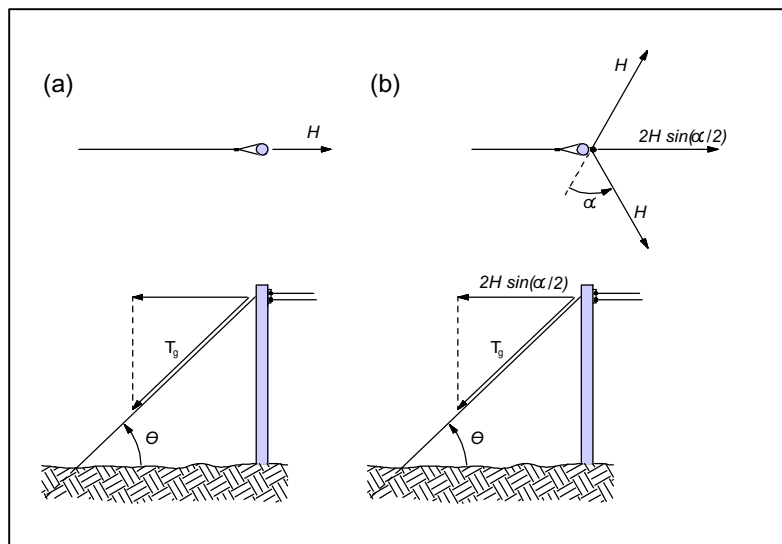


Fig. 74. Calculating guy tensions (a) at a deadend structure and (b) at a deviation along a line.

Guy at a deviation

If there is a deviation in the line equal to an angle of α , the conductors exert an unbalanced force in the direction that bisects the angles between the two conductors of a value shown in Fig. 74. Here, H is the sum of the horizontal forces of all the conductors in any one direction and is again approximately equal to the sum of the tensions in all the conductors in that direction. All the forces originating with the conductors must again be resisted by the guy, resulting in a tension in the guy of the following value:

$$T_g = \frac{2 H \cdot SF \cdot \sin\left(\frac{\alpha}{2}\right)}{\cos\theta}$$

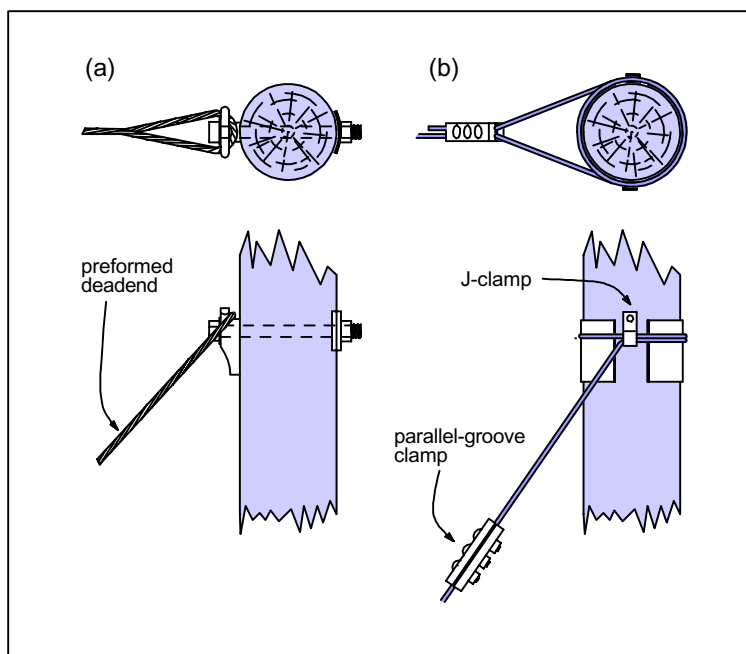


Fig. 75. Options for securing a guy wire to a pole.

Securing the guy to a pole

Fig. 75 illustrates two conventional ways of securing a guy wire to a pole. The first (a) requires a guy hook of any one of numerous designs (Fig. 76) mounted with a through bolt. With a wrapped type design (b), the guy wire encircles the pole over curved sheet metal plates to prevent the guy from biting into the grain of the wood. A J-clamp (Fig. 77) on each side of the pole prevents the guy wire from traveling down the pole. The guy wire is deadended by using either preformed deadends (p. 109), parallel groove clamps (p. 108), automatic deadends (p. 109) or U-bolts (Fig. 78).



Fig. 76. Guy hook attachment. (Source: Joslyn Manufacturing Co., Franklin Park, Illinois)



Fig. 77. J-hook. (Source: Joslyn Manufacturing Co., Franklin Park, Illinois)



Fig. 78. U-bolt clamp. (Source: Joslyn Manufacturing Co., Franklin Park, Illinois)

Types of anchor

Several approaches to anchoring can be applied in less accessible areas. The least expensive anchor is probably the deadman anchor. It has the advantage that its holding power can surpass that of other types of anchors because this can be changed by changing its size, in addition to its depth. Anchors of this type are commonly made of a section of a log. Even untreated logs can last a long time if adequately buried. At times, sections of concrete that have broken in transport have been used as anchors. This type of anchor is installed as shown in Fig. 79. The anchor rod is laid in an area which has been trenched out. As with all buried anchors, it is preferable to tie into them using threaded anchor rods that connects to the guy wire above ground because they are less susceptible to corrosion damage. A hole should be drilled through the log and a washer of adequate size used under the nut. As a less costly although possibly less durable alternative to using an anchor rod, the guy wire is sometimes painted with bitumen, placed around the anchor, and tied together with a guy (parallel groove) clamp.

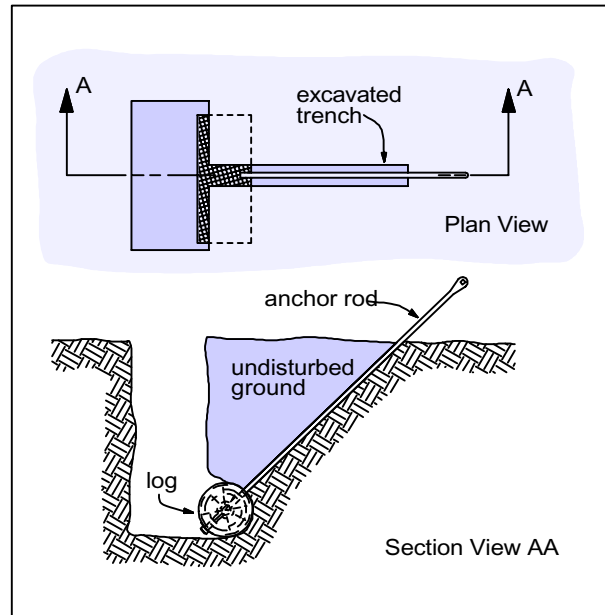


Fig. 79. Installation of a deadman anchor.

A second type of anchor is the plate anchor. Its installation is illustrated in Fig. 80. Because this anchor bears completely against undisturbed earth, it develops a large holding power in most soil. Where the cost of labor is high, the disadvantage with both of these types of anchors is that considerable labor could be required to dig a hole of adequate size and depth. In areas with vehicular access, this can sometimes be avoided through the use of screw anchors that are screwed into the ground. Power equipment is generally used for this purpose because considerable torque is required.

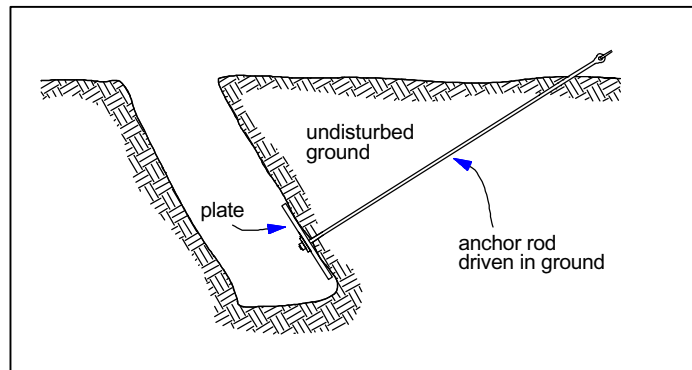


Fig. 80. Installation of a plate anchor.

Each of these anchors should be installed so that it rests beneath undisturbed earth as much as possible. The entire length of the anchor rod and the guy cable should be set in a straight line between the attachment on the pole and the point where the rod attaches to the anchor. If the rod is out of alignment, it will eventually pull into alignment, causing a lengthening of the guy-anchor assembly and permitting the pole to lean in the opposite direction.

A third alternative is an anchor rod cast into a circular block of concrete (Fig. 81). But this type of anchor most effectively works with a mechanized pole auger slightly larger than the diameter of the concrete block.

In solid rock, a rock anchor (Fig. 82) can be used. A hole the size of the anchor (and not larger) must be drilled in the rock. Once inserted, this anchor stays in place by driving it over a wedge that opens the end of the anchor, wedging it in place. A variety of rock anchors are available.

Sizing an anchor

Without extensive and costly soil tests, it is difficult to precisely determine the required size and depth of an anchor. It is more economical to oversize these. To size an anchor, it can be conservatively assumed that the anchor is held in the ground solely by the weight W of the soil directly above it (Fig. 83). And for an anchor to function properly, this weight must be at least equal to the component of the force in the guy wire pulling vertically.

$$T_g \cdot \sin \theta = W = w \cdot A \cdot D$$

In this equation, A represents the area of the anchor (m^2) as seen from above. An average value for the unit weight of soil (w) is $1,300 \text{ kg/m}^3$ or 13 kN/m^3 . This is a value for undisturbed soil, which should be the case if the anchor has been properly installed (as described earlier). To calculate the minimum depth at which the anchor must be buried, the above equation is solved for D :

$$D = \frac{T_g \cdot \sin \theta}{w \cdot A}$$

From an earlier equation, it can be seen that the value of T_g , already includes a safety factor SF . The value of D can be altered somewhat if it is felt that a modification of the safety factor is required.

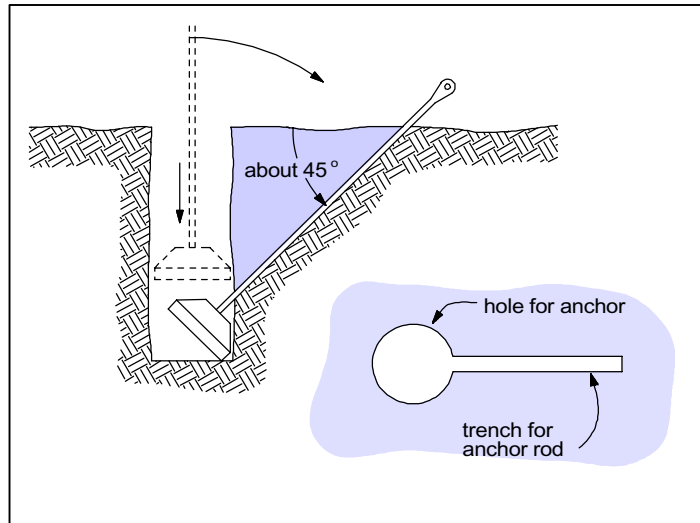


Fig. 81. Concrete block anchor.

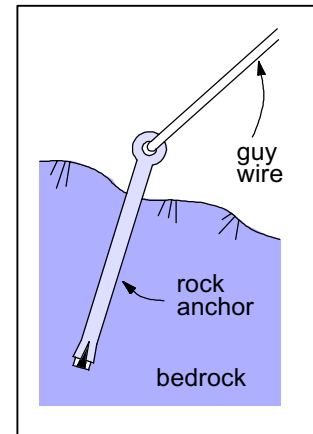


Fig. 82. Installation of a rock anchor.

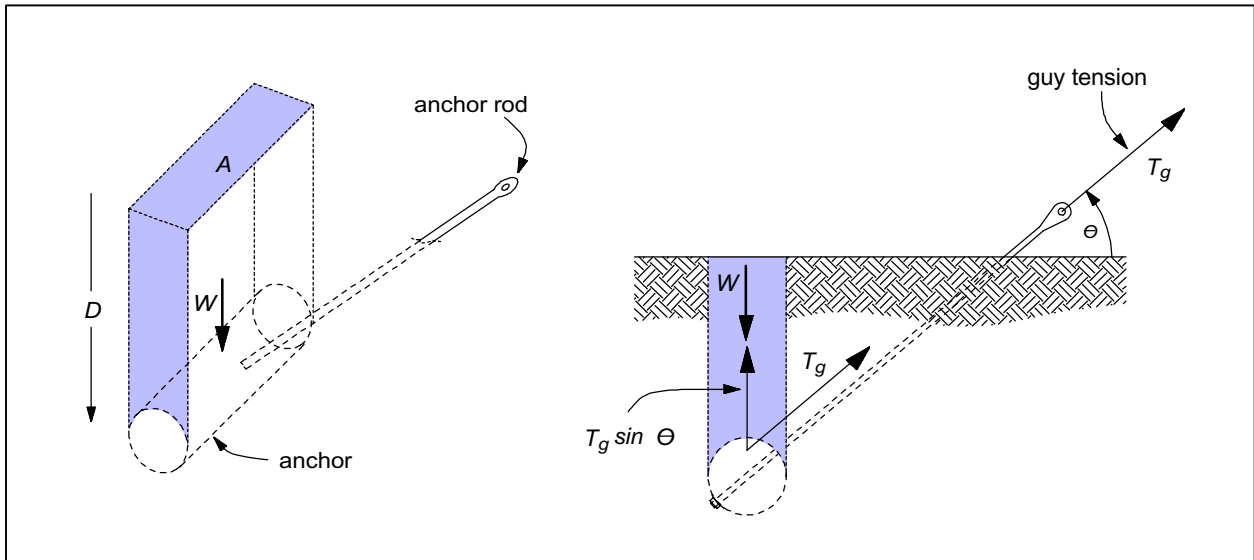


Fig. 83. An anchor is assumed to be restrained by the weight of the soil above it.