What conductors are normally used for overhead transmission lines?

Conductor Material Properties

Materials commonly used in conductors are aluminum, copper, and steel. The properties of these common materials fabricated as wires are summarized in Table 1.1. Galvanized steel wires are combined with aluminum in the most common type of overhead conductor -- Aluminum Conductor Steel Reinforced (ACSR). The use of copper is uncommon in modern transmission lines since it weighs and usually costs considerably more than aluminum conductor of the same resistance.

Conductor Design & Construction

"Standard" bare overhead conductors consist of round strands helically laid about a core in one or more layers.

In a homogeneous conductor - all aluminum conductor (AAC), hard drawn copper conductor (CU), or all aluminum alloy conductors (AAAC5005 or AAAC6201) - the core consists of a single strand identical to the outer strands. Since all the strands are the same diameter, one can show that the innermost layer always consists of 6 strands, the second layer of 12 strands, etc., making conductors having 1, 7, 19, 37, 61, 91, or 128 strands.

In a non-homogeneous conductor - aluminum conductor steel reinforced (ACSR), aluminum conductor alumoweld steel reinforced (ACSR/AW), or hard drawn copper conductor copperweld steel reinforced (CU/CW), or aluminum conductor aluminum alloy reinforced - the strands in the core may or may not be of the same diameter. In a 30/7 ACSR conductor the aluminum and steel strands are of the same diameter. In a 30/19 ACSR they are not. Within the core or within the outer layers, however, the number of strands always increases by 6 in each succeeding layer. Thus, in 26/7 ACSR, the number of layers in the inner layer of aluminum is 10 and in the outer layer 16.

The most common type of transmission conductor is ACSR. ACSR consists of one or more layers of aluminum strands surrounding a core of 1, 7, 19, or 37 galvanized steel strands. ACSR is manufactured in a wide range of sizes and strandings ranging from #6 AWG 6/1 (OD = 0.198 inches [5.1 mm]) to 2156 kcmil, 84/19 “Bluebird” (OD = 1.762 inches [45.5 mm]). Certain strandings are stronger than others. 36/1 ACSR is the weakest stranding (1/37 of the crossectional area is steel). 30/7 is the strongest (7/37 of the crossection is steel). The following tables group strandings of ACSR by strength according to a "Type No." classification where the Type No. is the percentage ratio of steel to aluminum crossectional areas.

Consider the following 795 kcmil (400 mm2) conductors listed in order of increasing rated breaking strength:

Comparison of mechanical properties for different strandings of 795 kcmil ACSR conductors (US Common Units).

Type No.	Code Name	Alum Wire No. x OD[in]	Steel Wire No. x OD[in]	Overall Diameter [in]	Rated Strength [lbs]	Total Weight [lbs/Kft]	Core Weight [lbs/Kft]
0	Arbutus	37 x 0.1466	None	1.026	13,900	746	0
3	Coot	36 x 0.1488	1 x 0.1488	1.040	16,800	805	59
7	Turbot	20 x 0.1994	7 x 0.0886	1.063	21,800	896	150
10	Puffin	22 x 0.1901	7 x 0.1056	1.077	24,800	958	212
16	Drake	26 x 0.1749	7 x 0.1360	1.108	31,500	1094	344
23	Skimmer	30 x 0.1628	7 x 0.1628	1.140	38,300	1246	483

Comparison of mechanical properties for different strandings of 400mm2 ACSR conductors (SI Units).

Type No.	Code Name	Alum Wire No. x OD[mm]	Steel Wire No. x OD[mm]	Overall Diameter [mm]	Rated Strength [N]	Total Weight [N/km]	Core Weight [N/km]
0	Arbutus	37 x 3.724	None	26.1	61 800	10 890	0
3	Coot	36 x 3.780	1 x 3.780	26.4	74 700	11 750	860
7	Turbot	20 x 5.065	7 x 2.250	27.0	97 000	13 080	2 190
10	Puffin	22 x 4.829	7 x 2.682	27.4	110 300	13 980	3 090
16	Drake	26 x 4.442	7 x 3.454	28.1	140 100	15 960	5 020
23	Skimmer	30 x 4.135	7 x 4.135	29.0	170 400	18 180	7 050

The stronger the ACSR conductor is, the higher the conductor tension under all conditions, and the less the conductor stretches under load (thus reducing sag increase for a given ice and wind loading). High strength strandings of ACSR also exhibit less thermal elongation and less high temperature creep so it is likely that the sag increase under high temperature conditions will be less. The major drawbacks to high strength ACSR are cost (a 30/7 ACSR conductor costs about 30% more than an all aluminum conductor of the same kcmil area), increased angle structure tension loads, and, under certain conditions, increased aeolian vibration induced fatigue of the aluminum strands.