(ACS) Aluminum Clad Steel Wires

Aluminum-clad Steel Wire

Construction

Aluminum-clad steel wire, commonly abbreviated as AW or AS or AC, is an electrical conductor composed of an inner steel core and outer Aluminum cladding. Aluminum clad steel wire is a bimetallic in which aluminum covers on the steel core continuously and evenly.

Advantages

Aluminum-clad steel wire is superior to galvanized or aluminized steel in every way.

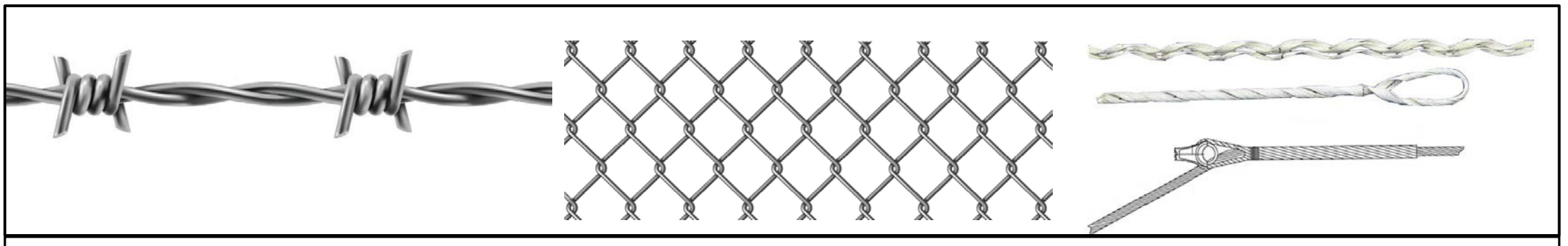
- Better corrosion resistance due to thick EC-grade aluminum covering
- Wider range of combinations of tensile strength and conductivity
- Lighter weight
- Excellent thermal stability
- Wider variety of products, with broad range of properties, quality, and size of steel wire and aluminum cladding.
- Compared with ordinary aluminum conductor steel reinforced, the conductor weight is 5% lighter, current-carrying capacity is 2-3% higher and power loss decreases 4-6%. Thus, the service life is long and it adds none erection cost.

Aluminum-clad Stranded Steel Wire

Application

The aluminum clad steel wire is widely used in long-span transmission line, coastal areas and island as well as other hot and humid regions, salt fog regions and heavily polluted regions where the high corrosion resistance strand is needed.

It is used as the core of ACSR/AW, overhead ground conductor, extra high voltage overhead conductor, optical fiber composite overhead ground line, self-damping conductor line, bare overhead conductor, OPGW, ground wire, messenger wire, guy wire formed wire for protecting, terminating and splicing transmission and distribution lines, fence, barber wire and hardware, etc.



Net fence, Barbed Wire & Armor Grip applications

Standards

APAR's Aluminum-clad Steel wire meets or exceeds the following specifications:
IEC 61232, ASTM B415, ASTM B502, AS 3607 and other International Standards.

However, can also supply a range of alternative designs with customized solutions to meet customer requirements.

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Abbreviations

AW : Aluminum-clad steel wire as per ASTM B 502 Standard.

AS : Aluminum-clad steel wire as per IEC 61232 Standard.

AC : Aluminum-clad steel wire as per AS 3607 Standard.

Classification of Aluminum Clad Steel wires

Class	14% IACS	20.3% IACS-A	20.3% IACS-B	23% IACS	27% IACS	30% IACS	35% IACS	40% IACS
Sectional Ratio of Al (%)	13	25	25	30	37	43	52	62
Sectional Ratio of St (%)	87	75	75	70	63	57	48	38
Weight Ratio of AL (%)	5	10.4	10.4	12.9	16.9	20.7	27.3	36.1
Weight Ratio of ST (%)	95	89.6	89.6	87.1	83.1	79.3	72.7	63.9

Physical Constants

Class	14% IACS	20.3% IACS-A	20.3% IACS-B	23% IACS	27% IACS	30% IACS	35% IACS	40% IACS
Nominal Density at 20°C (g/cm^3)	7.14	6.59	6.59	6.27	5.91	5.61	5.15	4.64
Final Modulus of Elasticity (Gpa)	170	162	155	149	140	132	122	109
Coefficient of Linear Exp. (per °C)	12×10^{-6}	13×10^{-6}	12.6×10^{-6}	12.9×10^{-6}	13.4×10^{-6}	13.8×10^{-6}	14.5×10^{-6}	15.5×10^{-6}
Temperature coefficient (per °C)	0.0034	0.0036	0.0036	0.0036	0.0036	0.0038	0.0039	0.004
% Elongation at Fracture on 250mm	1.5	1.5	1.5	1.5	1.5	1.5	1.5	1.5

The design of an aluminum-clad steel wire with a specified conductivity is based on 61 % IACS of aluminum and 9 % IACS of steel.

For example, the conductivity of 30% IACS is dealt with as follows:
Designed conductivity: Aluminum (61 % IACS x 0.43) + Steel (9 % IACS x 0.57) = 31.36 % IACS.

Then, taking into consideration allowances, minimum conductivity is specified as 30 % IACS (57.47 nΩm). When only the aluminum covering is taken into account as the conductive part in the conductor, the electrical resistance of aluminum-clad steel wires can be calculated by the cross-sectional area of aluminum as per above and the conductivity of 61 % IACS.

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Specifications for Aluminum Clad Steel Wires (Before Stranding)

Class	Type	Nominal Diameter (mm)		Min Tensile Strength (MPa)	Min stress at 1 % elongation (MPa)	Max. Resistivity at 20°C (nΩ·m)
		Over	Upto & Including			
14%1ACS	A	1.24	3.00	1590	1410	123.15
		3.00	3.50	1550	1380	
		3.50	4.75	1520	1340	
		4.75	5.50	1400	1200	
	B	2.10	4.00	1770	1550	
20%1ACS	-	1.24	3.25	1340	1200	84.80
		3.25	3.45	1310	1180	
		3.45	3.65	1270	1140	
		3.65	3.95	1250	1100	
		3.95	4.10	1210	1100	
		4.10	4.40	1180	1070	
		4.40	4.60	1140	1030	
		4.60	4.75	1100	1000	
		4.75	5.50	1070	1000	
	B	1.24	5.50	1320	1100	
23%1ACS	-	2.50	5.00	1220	980	74.96
27%1ACS	-	2.50	5.00	1080	800	63.86
30%1ACS	-	2.50	5.00	880	650	57.47
35%1ACS	A	2.50	5.00	810	590	49.26
	B	2.50	5.00	880	650	
40%1ACS	A	2.50	5.00	680	500	43.10
	B	2.50	5.00	750	550	

SINGLE WIRE AS PER ASTM B 415 STANDARD

Size AWG	Diameter		Tensile Strength		Cross section		D C Resistance at 20°C	Nominal Weight		Minimum Thickness of Aluminum Cladding	
	in.	mm	ksi	N/mm²	in²	mm²	Ω/km	lb/1000 ft	Kg/km	in	mm
(CONDUCTIVITY = 20.3 % IACS)											
4.0	0.204	5.189	155	1070	0.03278	21.149	4.010	93.67	139.37	0.01022	0.259
	0.188	4.775	160	1100	0.02776	17.909	4.735	79.32	118.02	0.00940	0.239
5.0	0.182	4.620	165	1140	0.02599	16.766	5.058	74.25	110.49	0.00910	0.231
	0.173	4.392	170	1170	0.02348	15.148	5.598	67.09	99.82	0.00865	0.220
6.0	0.162	4.115	175	1210	0.02061	13.298	6.377	58.89	87.63	0.00810	0.206
	0.155	3.934	180	1240	0.01884	12.158	6.975	53.84	80.12	0.00775	0.197
7.0	0.144	3.665	185	1280	0.01635	10.551	8.037	46.73	69.53	0.00722	0.183
	0.137	3.477	190	1310	0.01472	9.497	8.930	42.06	62.58	0.00685	0.174
8.0	0.129	3.264	195	1340	0.01297	8.367	10.135	37.06	55.14	0.00643	0.163
9.0	0.114	2.906	195	1340	0.01028	6.631	12.787	29.37	43.70	0.00572	0.145
10.0	0.102	2.588	195	1340	0.00816	5.261	16.117	23.30	34.67	0.00510	0.129
11.0	0.091	2.304	195	1340	0.00646	4.168	20.343	18.46	27.47	0.00454	0.115
12.0	0.081	2.052	195	1340	0.00513	3.308	25.634	14.65	21.80	0.00404	0.103

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Size AWG	Diameter		Tensile Strength		Cross section		D C Resistance at 20°C	Nominal Weight		Minimum Thickness of Aluminum Cladding	
	in.	mm	ksi	N/mm²	in²	mm²	Ω/km	lb/1000 ft	Kg/km	in	mm
(CONDUCTIVITY = 27 % IACS)											
4.0	0.204	5.189	125	862	0.03278	21.149	3.019	84.00	124.99	0.01430	0.363
	0.188	4.775	129	889	0.02776	17.909	3.566	71.13	105.84	0.01316	0.334
5.0	0.182	4.620	133	917	0.02599	16.766	3.809	66.59	99.09	0.01273	0.323
	0.173	4.392	137	945	0.02348	15.148	4.216	60.16	89.52	0.01210	0.307
6.0	0.162	4.115	141	972	0.02061	13.298	4.802	52.82	78.59	0.01134	0.288
	0.155	3.934	145	1000	0.01884	12.158	5.252	48.29	71.85	0.01084	0.275
7.0	0.144	3.665	150	1034	0.01635	10.551	6.052	41.91	62.36	0.01010	0.257
	0.137	3.477	154	1062	0.01472	9.497	6.724	37.72	56.12	0.00958	0.243
8.0	0.129	3.264	156	1076	0.01297	8.367	7.632	33.23	49.45	0.00900	0.228
9.0	0.114	2.906	156	1076	0.01028	6.631	9.629	26.34	39.19	0.00801	0.203
10.0	0.102	2.588	156	1076	0.00816	5.261	12.136	20.90	31.10	0.00713	0.181
11.0	0.091	2.304	156	1076	0.00646	4.168	15.319	16.56	24.64	0.00635	0.161
12.0	0.081	2.052	156	1076	0.00513	3.308	19.303	13.14	19.55	0.00566	0.144
(CONDUCTIVITY = 30 % IACS)											
4.0	0.204	5.189	102	703	0.03278	21.149	2.717	79.74	118.65	0.01532	0.389
	0.188	4.775	106	731	0.02776	17.909	3.209	67.52	100.47	0.01410	0.358
5.0	0.182	4.620	110	758	0.02599	16.766	3.428	63.21	94.06	0.01364	0.347
	0.173	4.392	114	786	0.02348	15.148	3.794	57.11	84.98	0.01297	0.329
6.0	0.162	4.115	114	786	0.02061	13.298	4.322	50.14	74.60	0.01215	0.309
	0.155	3.934	118	814	0.01884	12.158	4.727	45.84	68.21	0.01162	0.295
7.0	0.144	3.665	122	841	0.01635	10.551	5.447	39.78	59.19	0.01082	0.275
	0.137	3.477	126	869	0.01472	9.497	6.052	35.80	53.28	0.01027	0.261
8.0	0.129	3.264	128	883	0.01297	8.367	6.869	31.54	46.94	0.00964	0.245
9.0	0.114	2.906	128	883	0.01028	6.631	8.666	25.00	37.20	0.00858	0.218
10.0	0.102	2.588	128	883	0.00816	5.261	10.923	19.84	29.52	0.00764	0.194
11.0	0.091	2.304	128	883	0.00646	4.168	13.787	15.72	23.38	0.00680	0.173
12.0	0.081	2.052	128	883	0.00513	3.308	17.372	12.47	18.56	0.00606	0.154
(CONDUCTIVITY = 40 % IACS)											
4.0	0.204	5.189	80	552	0.03278	21.149	2.038	65.95	98.13	0.02554	0.649
	0.188	4.775	84	579	0.02776	17.909	2.407	55.85	83.10	0.02350	0.597
5.0	0.182	4.620	88	607	0.02599	16.766	2.571	52.28	77.79	0.02274	0.578
	0.173	4.392	92	634	0.02348	15.148	2.845	47.23	70.29	0.02161	0.549
6.0	0.162	4.115	96	662	0.02061	13.298	3.241	41.47	61.70	0.02025	0.514
	0.155	3.934	96	662	0.01884	12.158	3.545	37.91	56.41	0.01936	0.492
7.0	0.144	3.665	98	676	0.01635	10.551	4.085	32.90	48.96	0.01804	0.458
	0.137	3.477	98	676	0.01472	9.497	4.539	29.61	44.06	0.01711	0.435
8.0	0.129	3.264	99.5	686	0.01297	8.367	5.152	26.09	38.82	0.01606	0.408
9.0	0.114	2.906	99.5	686	0.01028	6.631	6.500	20.68	30.77	0.01430	0.363
10.0	0.102	2.588	99.5	686	0.00816	5.261	8.192	16.41	24.41	0.01274	0.324
11.0	0.091	2.304	99.5	686	0.00646	4.168	10.340	13.00	19.34	0.01134	0.288
12.0	0.081	2.052	99.5	686	0.00513	3.308	13.029	10.32	15.35	0.01010	0.257

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SINGLE WIRE AS PER ASTM B 502 STANDARD

Diameter		Tensile Strength		Stress at 1% Extension		Resistivity		Density	
in.	mm	ksi	N/mm²	ksi	N/mm²	Ω.Cmil/ft	n.Ωm	lb/in^3	g/cm^3
0.0770 ~ 0.1289	1.956 ~ 3.274	195	1344	175	1206	51.01	84.8	0.2381	6.59
0.1290 ~ 0.1369	3.275 ~ 3.477	190	1310	170	1172				
0.1370 ~ 0.1443	3.478 ~ 3.665	185	1275	165	1137				
0.1444 ~ 0.1549	3.666 ~ 3.934	180	1241	160	1103				
0.1550 ~ 0.1620	3.935 ~ 4.115	175	1206	160	1103				
0.1621 ~ 0.1729	4.116 ~ 4.392	170	1172	155	1068				
0.1730 ~ 0.1819	4.393 ~ 4.620	165	1137	150	1034				
0.1820 ~ 0.1880	4.621 ~ 4.775	160	1103	145	1000				

Coefficient of linear expansion : 12.6 x 10^{-6} /°C
Modulus of Elasticity : 23500 Ksi (162000 MPa)
Temperature coefficient of Resistance: 0.0036/°C
Minimum Aluminum Thickness : 10% of nominal wire radius

SINGLE WIRE AS PER AS-3607 STANDARD

Diameter (mm)			Tensile Strength		Cross section	D C Resistance at 20°C	Nominal Weight	Minimum Thickness of Aluminum Cladding	
Std	Max	Min	N/mm²	KN	mm²	Ω/km	Kg/km	in	mm
1.600	1.640	1.560	1340	2.69	2.011	42.28	13.25	0.080	
1.750	1.790	1.710	1340	3.22	2.405	35.34	15.85	0.088	
2.250	2.290	2.210	1340	5.33	3.976	21.38	26.20	0.113	
2.500	2.540	2.460	1340	6.58	4.909	17.32	32.35	0.125	
2.750	2.791	2.709	1340	7.96	5.940	14.31	39.14	0.138	
3.000	3.045	2.955	1340	9.47	7.069	12.03	46.58	0.150	
3.250	3.299	3.201	1340	11.12	8.296	10.25	54.67	0.163	
3.500	3.553	3.448	1310	12.60	9.621	8.83	63.40	0.175	
3.750	3.806	3.694	1270	14.03	11.045	7.70	72.78	0.188	

Coefficient of linear expansion : 12.9 x 10^{-6} /°C
Modulus of Elasticity : 23500 Ksi (162000 MPa)
Temperature coefficient of Resistance: 0.0036/°C
Minimum Aluminum Thickness : 10% of nominal wire radius