APAR

Tomorrow's solutions today

RAILWAY OVERHEAD CONDUCTORS

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ABOUT APAR

APAR Industries Limited, founded by Late Mr. Dharmsinh D. Desai in the year 1958 is one among the best established companies in India operating in the diverse fields of electrical, metallurgical and chemical engineering. Over the ensuing years it has evolved to be a 1 Billion US Dollar diversified company offering value added products and services in Power Conductors, OPGW Products, Wire & Cables, Copper Products and Petroleum Specialities.

A technology - driven and customer - focused vendor to some of the most brand enhancing power companies in India and abroad, APAR has strengthened the business of its customers through proactive product development, timely product delivery and superior product attributes by reinforcing product innovation, cost leadership and premium quality and living its vision 'Tomorrow's Solution Today' resulting in Reliability, Respect, Reputation and Repeat business across customers of Power Conductors, OPGW, Wire & Cables, Copper Products and Petroleum Specialties.

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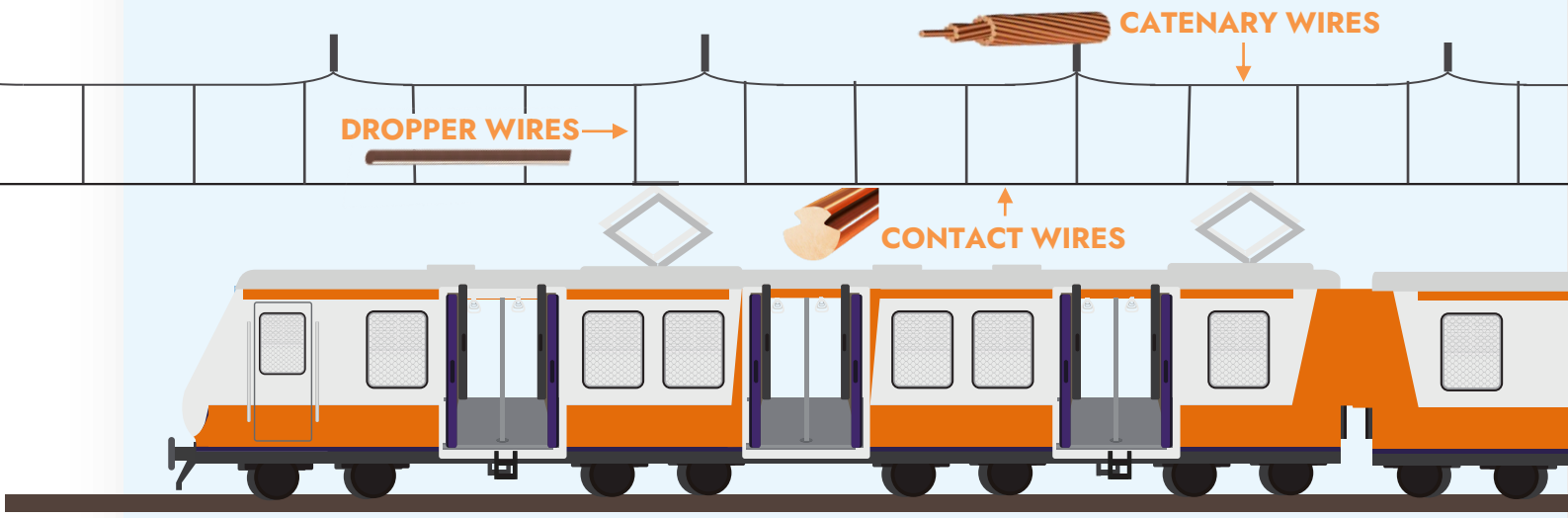
UNDERSTANDING OUR PRODUCTS

APAR manufactures product range that covers the entire spectrum of bare wires used in electrically operated railway infrastructure:



All above product comply with all the National and International standards, EN, ASTM, IS as well as RDSO (Indian railway) Specification.

CONTACT WIRE (HDGC) /TROLLEY WIRES

Available in:
Diverse alloys
Diverse Section From 80 mm^2 to 193 mm^2-
Diverse shapes: circular, flat

CATENARY WIRES

Available in:
Diverse Section
Diverse Alloys Diverse Composition

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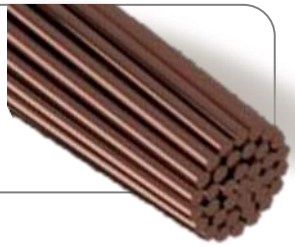
PRODUCT RANGE

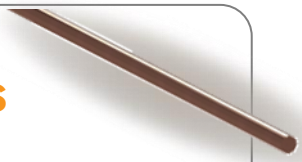
JUMPER WIRES

FEEDER WIRES

SPAN WIRES



DROPER WIRES



BRIDDLE WIRES

ANTI-CREEP WIRES

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COPPER & ALLOYS

- The basic application of contact wire is carrying current for railway traction.
- Electric trains that collect current from overhead lines use a device such as a pantograph, Low collector or trolley pole. It presses against the underside of the lowest overhead wire that is called CONTACT WIRE.
- Mainly contact wire made from copper or copper alloy with different cross section area from 80 mm^2 to 193 mm^2 in different alloy form.

Different Type of Copper alloy is mentioned below:

1) Normal and High Strength Copper:-

Mainly used in INDIA RAILWAY-RDSO.

Copper ETP is still the most universal metal, but is increasingly being replaced by alloys with better characteristics. Non-alloyed Cu offer the best possible conductivity, and is typically used in contact wires for tramways and conventional railway lines but is most appropriate for auxiliary conductor and feeder cables.

2) Copper-Silver Alloy:-

This alloy offer electrical and mechanical characteristics similar to copper, but has better thermal stability. This allows higher over current on DC lines, without increasing the wear on the contact wire.

3) Copper-Cadmium Alloy:-

Copper cadmium combines high strength with good conductivity. With unsurpassed flex, CuCd is highly resistance to the frequent vibrations that ideal choice for high energy efficiency, reduced voltage drop and operational cost saving.

4) Copper-Magnesium Alloy:-

Copper Magnesium has the highest tensile strength when compared to other alloy, making it the perfect alloy for contact wire in high speed line with speed well above 300 km/h. Together it is the perfect alloy for the messenger/catenary cable, having the appropriate strength to carry the entire catenary system.

5) Copper-Tin Alloy:-

The development of a high performance Copper-Tin alloy was an imperative, displaying the right balance of electrical and mechanical properties. CuSn has applications for use in the contact wires for both high-speed and conventional railway lines.

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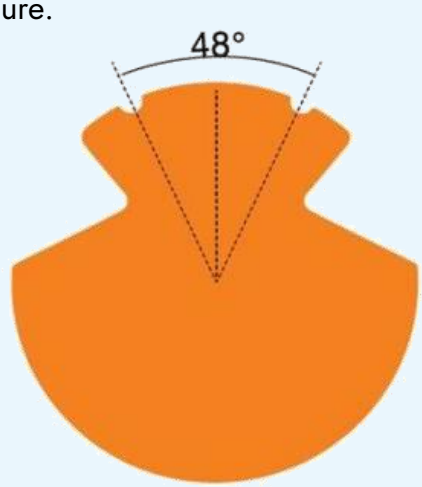
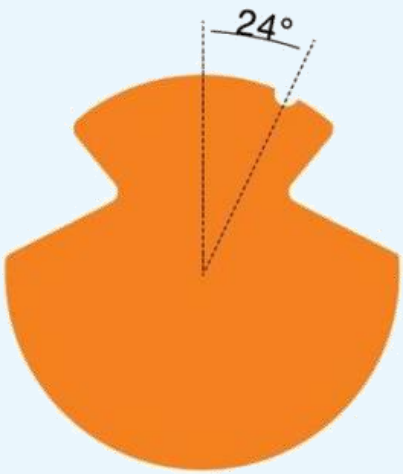
CONTACT WIRES

Identification of Different Type of Contact wire : *As per EN 50149:2012

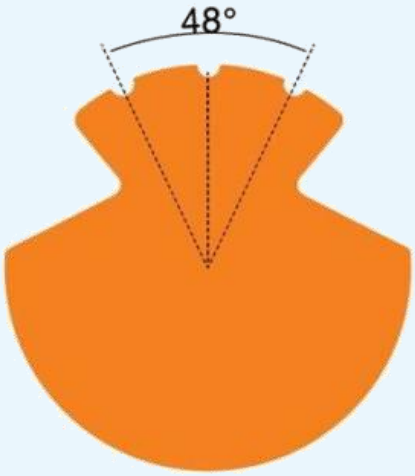
All wire manufactured from alloys shall be clearly identified for normal and high strength copper and copper-silver, copper-cadmium. Copper-magnesium and copper- tin alloy the method of identification shall be by identification grooves as shown in below figure.



Contact wires made of copper-silver alloy have two identical identification grooves on the upper lobe of the wire



Contact wires made of copper-tin alloy have one identification groove on the upper lobe of the wire at an angle of 24° from the vertical.



Contact wires made of copper-magnesium alloy have three identification grooves on the upper lobe of the wire.

Contact wires made of copper Cadmium alloy have one identical groove on the upper lobe of the wire

Contact wires made of pure copper (Cu-ETP) do not have identification grooves

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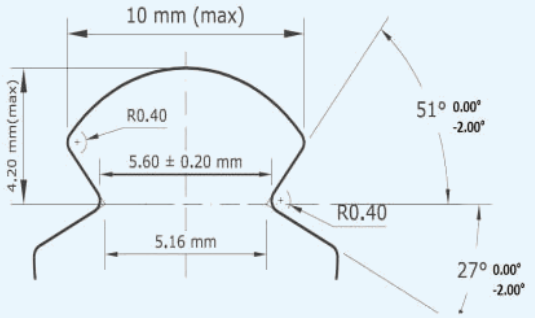
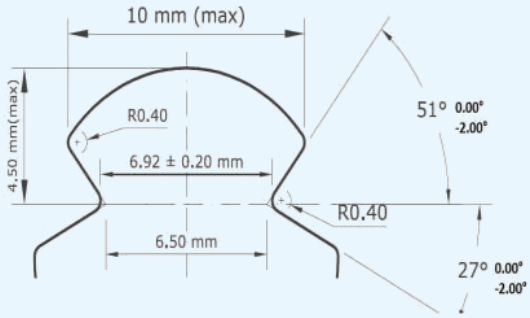
CONTACT WIRES

Identification of Different Sections of Contact wire :
*As per EN 50149:2012

Whatever cross section of the contact wire id used, the dimensions of clamping grooves are accordance with either TYPE A or TYPE B as given in below figure.

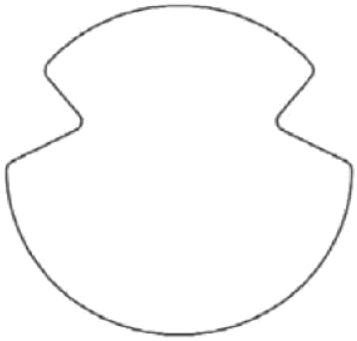


TYPE A CLAMPING GROOVE

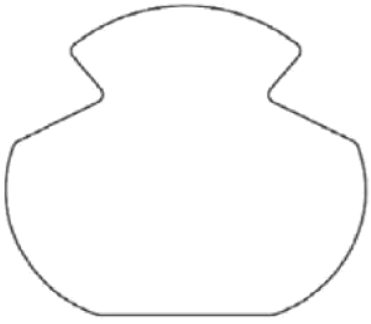


TYPE B CLAMPING GROOVE

Also, whatever clamping grooves is used; the main two types of profile are in accordance with either CIRCULAR TYPE or FLATTENED TYPE as given in below figure



CIRCULAR TYPE WIRE



FLATTENED TYPE WIRE

Nomenclature based on clamping grooves and shape of the contact wire
Example, AC-107

1) We can manufacture AC-107 with Type A Clamping groove having Circular bottom.
2) We can manufacture AC-107 with Type B Clamping groove having Circular bottom.
3) We can manufacture AC-107 with Type A Clamping groove having Flat bottom.
4) We can manufacture AC-107 with Type B Clamping groove having Flat bottom.

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CONTACT WIRES

Identification of Different Sections of Contact wire :
*As per EN 50149:2012

Common alloy compositions and designations									
Some possible material compositions and designations									
Material designation		Composition in %							
		Element							
Material group	Symbol		Cu	Bi	O	P	Pb	Other elements	
								Total	Excluding
Normal and high strength copper	Cu-ETP	Min.	99.90a	-	-	-	-	-	Ag, O
		max.	-	0.0005	0.040 b	-	0.005	0.03	
	Cu-FRHC	Min.	99.90a	-	-	-	-	-	Ag, O
		max.	-	-	0.040 b	-	-	0.04	
	Cu-OF	Min.	99.95	-	-	-	-	-	Ag
		max.	-	0.0005	c	-	0.005	0.03	
	Cu-HCP	Min.	99.95	-	-	0.002	-	-	Ag, P
		max.	-	0.0005	c	0.007	0.005	0.03	
			Cu	Bi	O		Ag	Other elements	
								Total	Excluding
Normal and high strength copper-silver-alloy	CuAg, 0.1	Min.	Rest	-	-	-	0.08	-	Ag, O
		max.	-	0.0005	0.04	-	0.012	0.03	
			Cu	Mg	Sn	Cd	p	Other elements	
								Total	Excluding
Copper-magnesium alloy	CuMg, 0.2	Min.	Rest	0.1	-	-	-	-	Mg, P
		max.		0.3	-	-	0.01	0.01	
	CuMg, 0.5	Min.	Rest	0.4	-	-	-	-	Mg, P
		max.		0.7	-	-	0.01	0.01	
Copper-tin alloy	CuSn, 0.2	Min.	Rest	-	1.15	-	-	-	Sn
		max.		-	0.55		-	0.01	
Copper- cadmium-alloy	CuCd, 0.7	Min.	Rest	-	-	0.5	-	-	Cd
		max.		-	-	0.8	-	0.01	
	CuCd, 1.0	Min.	Rest	-	-	0.8	-	-	Cd
		max.		-	-	1.2	-	0.01	

a Including silver, up to a maximum of 0,015 %.

b Oxygen content up to 0,060 % is permitted, subject to agreement between the purchaser and the supplier.

c The oxygen content shall be controlled by the manufacturer so that the material conforms to the hydrogen embritlement requirements.

NOTE 1 Composition of all copper types are in accordance with EN 1977:1998.

NOTE 2 The total of other elements (than copper) is defined in EN 1977: 1998 as the sum of Ag, As, Bi, Cd, Co, Cr, Fe, Mn, Ni, 0, P, Pb, S, Sb, Se, Si, Sn, Te and Zn, subject to the exclusion of any individual elements indicated.

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CONTACT WIRES

Physical constant:
*As per EN 50149:2012

Material Group	Cu-ETP & Hard Darwn	CuAg	CuMg	CuSn	CuCd
Nominal Density at 20°C (g/cm^3)	8.89	8.89	8.89	8.92	8.945
Final Modulus of Elasticity (Gpa)	120	120	120	120	120
CLE (per °C)	17 x 10^{-6}	17 x 10^{-6}	17 x 10^{-6}	17 x 10^{-6}	17 x 10^{-6}
Maximum Resistivity at 20°C ohm.mm²/Km	17.77	17.77 for CuAg 0.1	22.4 for CuMg 0.2 Normal Conductivity	20.05 for CuSn 0.2 Normal Conductivity	20.05 for CuCd 0.7
			21.55 for CuMg 0.2 High Conductivity	21.55 for CuSn 0.2 High Conductivity *	21.55 for CuCd 1.0
			27.78 for CuMg 0.5		
Temperature Coefficient (per °C)	0.0038	0.0038	0.0031 0.0027 for CuMg 0.5	0.0032	Agreed between purchaser and manufacturer
* CuSn 0.2 (High Conductivity) was previous denoted CuSn 0.4					
1) In a temperature range from -50°C up to 100°C the coefficient of temperature for the resistance is constant					

Contact Wire as per EN 50149 : 2012
Maximum Resistance/Kilometer

Nominal cross section mm²	Material designation a						
	Cu-ETP Cu-OF Cu-FRHC Cu-HCP	CuAg 0.1	CuMg 0.2	CuMg 0.5	CuSn 0.2	CuCd 0.7	CuCd 1.0 CuSn0.2 (high conductivity) b CuMg 0.2 (high conductivity)
80	0.229	0.229	0.289	0.385	0.309	0.258	0.278
100	0.183	0.183	0.231	0.286	0.247	0.207	0.222
107	0.171	0.171	0.216	0.268	0.231	0.193	0.208
120	0.153	0.153	0.192	0.239	0.206	0.172	0.185
150	0.122	0.122	0.154	0.191	0.165	0.138	0.148
a value in Ω/Km at 20°C - Calculated on minimum cross section area							
b CuSn 0.2 (Gigh Conductivity) was previous denoted CuSn 0.4							

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CONTACT WIRES

Tensile Strength, Breaking load and after Elongation Fraction

Material	Designation	Nominal cross section mm²	Percentage elongation after fracture A200		Minimum tensile strength Mpa a	Minimum breaking load kN
			min %	Max. %		
Normal strength Copper	Cu-ETP Cu-FRHC Cu-HCP CuOF	80	3	10	355	27.5
		100	3	10	355	34.5
		107	3	10	350	36.3
		120	3	10	330	38.4
		150	3	10	310	45.1
High strength copper and high strength copper-silver alloy	CuETP CuFRHC CuHCP CuOF CuAg 0.1	80	3	8	375	29.1
		100	3	8	375	36.4
		107	3	8	360	37.4
		120	3	8	360	41.9
		150	3	8	360	52.4
Normal strength copper-silver alloy	CuAg 0.1	80	3	10	365	28.3
		100	3	10	360	34.9
		107	3	10	350	36.3
		120	3	10	350	40.7
		150	3	10	350	50.9
Copper-magnesium alloy	CuMg 0.2	80	3	10	460	35.7
		100	3	10	450	43.7
	CuMg 0.2 (high conductivity)	107	3	10	440	45.7
		120	3	10	430	50.1
		150	3	10	420	61.1
Copper-magnesium alloy	CuMg 0.5	80	3	10	520	40.4
		100	3	10	510	49.5
		107	3	10	500	51.9
		120	3	10	490	57.0
		150	3	10	470	68.4
Copper-Tin Alloy	CuSn 0.2	80	2	8	460	40.4
		100	2	8	450	49.5
	CuSn 0.2 (high conductivity)	107	2	8	430	51.9
		120	2	8	420	57
		150	2	8	420	68.4
Copper-cadmium Alloy	CuCd0.7	80	2	7	430	33.4
		100	2	7	430	41.7
		107	2	7	430	44.6
		120	2	7	430	50.1
		150	2	7	430	62.6
Copper-Tin Alloy	CuCd1.0	80	2	7	455	35.3
		100	2	7	445	43.2
		107	2	7	445	46.2
		120	2	7	445	51.8
		150	2	7	445	64.7

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CONTACT WIRES

Contact Wire as per IS 3476:1986
HARD DRAW COPPER TROLLY AND CONTACT WIRE

Cross Sectional Area	Standard weight a	Maximum Resistance at 20°C b	Minimum Tensile Strength	Conventional limit of elasticity c	Minimum Elongation in 200 mm	Minimum Number of bending
mm²	kg/km	ohm/km	Kg/mm²	Kg/mm²	%	Nos
80	711.2	0.2275	38	32.5	3	8
100	889	0.1818	36.5	31	3	7
107	951.2	0.1699	36.5	31	3	7
150	1333.5	0.1212	35.6	31	3	6
161	1431	0.1125	33	-	3	6
193	1715.8	0.0936	31	-	4	5
a	value correspond to the standard cross sectional area					
b	value correspond to the minimum cross sectional area and minimum tensile strength of wire					
c	For information only					

HARD DRAW CADMIUM-COPPER TROLLY AND CONTACT WIRE

Cross Sectional Area	Standard weight	Maximum Resistance at 20°C	Minimum Tensile Strength	Conventional limit of elasticity	Minimum Elongation in 200 mm	Minimum Number of bending
	a	b		c		
mm²	kg/km	ohm/km	Kg/mm²	Kg/mm²	%	Nos
100	894.5	0.2116	44	37.5	2.5	7
107	957.1	0.1977	44	37.5	2.5	7
150	1342	0.1411	44	37.5	2.5	6

a = value correspond to the standard cross sectional area
b = value correspond to the minimum cross sectional area and minimum tensile strength of wire
c = For information only

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CONTACT WIRES

Contact Wire as per RDSO AIL-ETI-OHE-76-6-97

Material Group	Nominal Density at 20°C (g/cm^3)	Final Modulus of Elasticity (Gpa)	CLE (per °C)	Maximum Resistivity at 20°C ohm.mm²/Km	Temperature Coefficient (per °C)
Copper Cadmium	8.945	120	17 x 10^{-6}	21.769	0.0031
Copper Magnesium	8.89	120	17 x 10^{-6}	*	0.00185

1) In a temperature range from -50°C up to 100°C the coefficient of temperature for the resistance is constant

* Under progress

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CATENARY WIRES

Physical Constant (*As epr RDSO)

For Copper wire bar/copper cathode/CC copper Rod						
Cu + Ag	Bi + Te + Se	Pb	Sb	AS	Sn + N I + Fe + Si + Zn + CO	Oxygen
99.90%	<20 ppm	<5 ppm	<4 ppm	<5 ppm	<50 ppm	<450 ppm

For Cadmium Copper Billets								
Cu + Ag	Cd	P	Bi + Te + Se	Pb	Sb	AS	Sn + Ni + Fe + Si + Zn + CO	Oxygen
>= 98.90 %	0.7 to 0.1 %	<50 ppm	<20 ppm	<5 ppm	<4 ppm	<5 ppm	<50 ppm	<450 ppm

Cadmium Copper (CuCd) Catenary Wire (*As epr RDSO)

Chemical Composition

Nominal equivalent area of hard drawn copper	No. of strand and diameter of wire	Approx overall Diameter	Weight per km			Resistance per km at 20°C corrected to std Weight		Minimum breaking load of conductor	Calculated area of cadmium copper
			Std	Max	Min	Std	Max		
mm²	mm	mm	Kg	Kg	Kg	Ohm	Ohm	Kgf	mm²
20	7/2.10	6.3	218.7	223	214.3	0.905	0.914	1443	24.04
53	19/2.10	10.5	597.3	609.2	585.3	0.336	0.339	3920	64.84
102	37/2.10	14.7	1169	1193	1146	0.173	0.175	7650	125.6

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CATENARY WIRES

Mechanical and Electrical properties of Catenary Wire

Cross Section	Diameter of CCC wire rod		Standard Weight per Km a	Resistance per Km at 20°C b	Tensile Strength	Conventional Limit of Elasticity	Elongation in 200 mm	No. of Bending	Hardness
Nominal	Min	Max	Nominal	Nominal	Min	Min	Min	Min	Min
mm^2	mm	mm	Kg	Ohms	Kgf/mm^2	Kgf/mm^2	%	Nos	BHN
107	19	22	951.2	0.166	36.5	31	3	7	107
150	23	27	1333.5	0.1184	36.5	31	3	6	107
161	23	27	1431.3	0.1103	36.5	31	3	6	107
193	23	27	1715.8	0.0921	36.5	31	3	5	107
a & b = Value correspond to nominal cross section area of HDGC Contact wire									

Magnesium Copper (CuMg) Catenary Wire (*As epr RDSO) Chemical Composition

Cu + Ag	Mg	Bi	Pb	P	Oxygen
Remaining	0.1 to 0.7 %	<10 ppm	<5 ppm	<50 ppm	<20 ppm

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CATENARY WIRES

Mechanical and Electrical properties of Catenary Wire

Nominal equivalent area of hard drawn copper	No. of strand and diameter of wire	Approx overall Diameter	Weight per km			Resistance per km at 20°C corrected to std Weight		Minimum breaking load of conductor	Calculated area of cadmium copper
mm²	mm	mm	Std Kg	Max Kg	Min Kg	Std Ohm	Max Ohm	Kgf	mm²
19.84	7/2.10	6.3	217.6	221.76	213.58	0.8958	0.9123	1432.7	24.05
53.5	19/2.10	10.5	594.4	605.78	583.41	0.3322	0.3387	3915.9	64.85
103.62	37.2.10	14.7	1163.5	1185.8	1142	0.1717	0.175	7625.7	125.6

As per RDSO Draft Specification, Approval Under progress

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JUMPER WIRES

Material	:	160 Sq. mm (19/7/1.25 mm) Copper Jumper Wire
Sr. No.	**Parameter**	**Specified Value**
On Stranded Conductor		
1	Over all Diameter	18.75 mm
2	Resistance	0.1117 ohm/Km (Max.)
3	Weight	1504.00 Kg/Km
4	Configuration	19/7/1.25 mm
5	Lay Length	1st Layer - 30 to 60 mm
		2nd Layer - 90 to 180
		3rd Layer - 150 to 300
On Single Wire After Stranding		
1	Diameter	Std : 1.250 mm Max : 1.263 mm Min : 1.237 mm
2	Elongation	20% (min)

Material	:	105 Sq. mm (19/7/1.016 mm) Copper Jumper Wire
Sr. No.	**Parameter**	**Specified Value**
On Stranded Conductor		
1	Over all Diameter	15.24 mm
2	Resistance	0.1689 Ω /Km (Max.)
3	Weight	993.6 Kg/Km
4	Configuration	19/7/1.016 mm
5	Lay Length	1st Layer - 24 to 49 mm
		2nd Layer - 73 to 146 mm
		3rd Layer - 122 to 244 mm
On Single Wire After Stranding		
1	Diameter	Std : 1.016 mm Max : 1.026 mm Min : 1.006 mm
2	Elongation	20% (min)

Material	:	50 Sq. mm (19/1.80 mm) Copper Jumper Wire
Sr. No.	**Parameter**	**Specified Value**
On Stranded Conductor		
1	Over all Diameter	9.00 mm
2	Resistance	0.3705 Ω /Km (Max.)
3	Weight	438.0 Kg/Km
4	Configuration	19/1.80 mm
5	Lay Length	1st Layer - 54 to 86 mm
		2nd Layer - 90 to 144 mm
On Single Wire After Stranding		
1	Diameter	Std : 1.800 mm Max : 1.818 mm Min : 1.782 mm
2	Elongation	20% (min)

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FEEDER WIRE & SPAN WIRE

Material :	150 Sq. mm (37/2.25 mm) Copper Feeder Wire	
Sr. No.	**Parameter**	**Specified Value**
	On Stranded Conductor	
1	Over all Diameter	15.75 MM
2	Resistance	0.1248 ohm/Km (Max.)
3	Weight	1299.48 to 1352.52 Kg/Km
4	Configuration	1 + 6 + 12 + 18
5	Lay Length	1st Layer - 90 to 112 (RHS)
		2nd Layer - 135 to 157 (LHS)
		3rd Layer - 168 to 202 (RHS)
	On Single Wire Before Stranding	
1	Diameter	2.227 to 2.272 mm
2	Weight	34.653 to 36.067 Kg/Km
3	Resistance	4.563 ohm/Km (Max.)
4	Breaking Load	179 Kgf Min
5	Tensile Strength	46 Kgf/mm^2
	On Single Wire After Stranding	
1	Diameter	2.227 to 2.272 mm
2	Weight	34.653 to 36.067 Kg/Km
3	Resistance	4.563 ohm/Km (Max.)
4	Breaking Load	179 Kgf Min
5	Tensile Strength	46 Kgf/mm^2

Material :	130 Sq. mm (37/2.10 mm) span Wire	
Sr. No.	**Parameter**	**Specified Value**
	On Stranded Conductor	
1	Diameter	14.7 mm approx.
2	Resistance	0.1750 ohm/Km (Max.)
3	Weight	1145.8 to 1192.6 Kg/Km
4	Configuration	1 + 6 + 12 + 18
5	Lay Length	1st Layer - 84 to 105 (RHS)
		2nd Layer - 126 to 147 (LHS)
		3rd Layer - 158 to 189 (RHS)
	On Single Wire Before Stranding	
1	Diameter	2.08 to 2.12mm
2	Weight	30.36 to 31.60
3	Resistance	6.348 ohm/Km (Max.)
4	Breaking Load	225 Kgf Min
5	Tensile Strength	66.14 Kgf/mm^2
	On Single Wire After Stranding	
1	Diameter	2.08 to 2.12mm
2	Weight	30.36 to 31.60
3	Resistance	6.348 ohm/Km (Max.)
4	Breaking Load	208 Kgf Min
5	Tensile Strength	61.18 Kgf/mm^2

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Corporate Office

APAR Industries Limited APAR House,
Corporate Park, V N Purav Marg
Chembur, Mumbai 400 071, India

Tel: +91 22 25263400 / 6780 0400
Fax: +91 22 25246326

Registered Office

301 / 306, Panorama Complex,
RC Dutt Road, Vadodara 390 007, INDIA

Tel: +91 265 2323 175 / 2323 176

Send your enquiry to: sneha.patel@apar.com, shobanbabu.surya@apar.com | **Web :** www.apar.com

@aparindustrieslimited @AparIndustriesLtd apar_industries_limited @AparIndustries Apar Industries Limited