# DICABS 

## Conductors

## CONDUCTORS

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## DIAMOND POWER INFRASTRUCTURE LIMITED

## Dear Fellow Power Engineers \& Esteemed Customers


#### Abstract

With our best regards to all our fellow power Engineers, Consultants and valued customers, we take this opportunity to put forward "Revised-updated-conductor Manual" for your reference and parting further more technical updated details with inclusion of more technical parameters as regards to conductor field.

We have had overwhelming response for our earlier conductor - manual, by which we had put our best possible efforts to provide the technical assistance to all Government/Public sector corporates by providing all important technical parameters keeping in view Indian as well as International standards for achieving proper selection aspects as far as overhead conductor selection / usage is concerned.

The publication of this revised-updated conductor-manual, is dedicated to our esteemed customer consultants and all Government/ Private Sector /Public Sector,Corporates as a reference guide - which will help all those who are associated and involved in development of overhead transmission and distribution field.


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## Small beginnings; Big dreams

Back in 1971, DPIL began with just one product and one customer in the portfolio. The Company was established with an objective of catering to the escalating demand of the Indian industry for high-performance Cables and Conductors. We adopted a modern approach in terms of technology and capability, enabling us to deliver gobal standards of quality, right from dayone.

Today, Diamond Power infrastructure Ltd. is a USD 441 million Company with end to end manufacturing facilities for comprehensive range of Transmission \& Distribution Conductors, Power. HT, EHV \& Control Cables. We are the country's first and only integrated Cable manufacturer with Rod to Insulation facility under one roof and have delivered more than $10,00,000 \mathrm{kms}$. of products to over 150 clients worldwide.

## Fast Facts

- Established in 197|
- Manufacturing facilities at Baroda \& Silvassa
- First Indian Company to develop the Alloy Conductor indigenously in 1989
- ISO 9001 : 2008, ISO 14000 \& ohsas 18001 certified

- One of the first manufacturers in the world to use a SAP-ERP System
- Installed capacity of 32,000 MT. per annum for Rods.
- Installed capacity of 50,500 MT. per annum for ACSR, AAAC \& AAC Conductors
- Installed capacity to make $11,500 \mathrm{kms}$. per annum of Power, Control and Aerial Bunch Cables


## Backward integration; Forward thinking.

We believe that if the basics are right, progress is inevitable; because the foresight necessary to become a leader comes from the ability to build on hindsight.
To underscore this ethos, we have indigenized several quality-relevant processes and operations to enable a better control over the parameters that define our product characteristics; resulting in better quality delivered to our clients.

As part of our endeavor to be fully integrated, we went in for backward integration way back in 1999 by setting up an Aluminium Wire Rods manufacturing unit. In doing this, DPIL became the country's only integrated manufacturer of Cables and Conductors. In 1989,
became the first company to indigenously develop Alloy Conductors. Our R\&D centre has also patented a superior HSHC (High Strength High Conductivity) conductor with better technical and physical characteristics than conventional conductors for transmission systems.

## Pioneering innovation; Delivering quality.

Our endeavour to continuously improve has translated into innovative technologies and products that have broken new ground in the industry. The state-of-the-art Research \& Development centre at Vadodara is equipped with sophisticated equipments to facilitate extensive research and generate revolutionary technologies.

Presently, the R\&D centre is developing a High Conductivity High Strength Aluminium Alloy, suitable to work in high temperatures with better creep, fatigue and other mechanical properties. This would result in reduced losses and improved voltage regulations in transmission system.

## DPIL Innovates

- Improved Lubrication and Cooling Cycles and superior designs of Wire Drawing Dyes to suit High Tensile Aluminium Alloy Drawing at very high speeds
- Heat Treatment Furnace redesigned to reduce heat loss, increasing capacity three times the conventional furnace
- Stranding Machines provided with automatic loading/ unloading system and auto wire brakes stop etc.


## Cutting-edge technology; New-age facilities



Our infrastructural base comprises two state-of-the-art manufacturing plants. The facilities are spread over 260 Acres, which also include the Warehouse and the R\&D centre of the Company.

## Integrated Plant: Vadadala, Vadodara

The Company's present manufacturing facility was set up at village Vadadala, Ta. Savli, Dist. Vadodara, 400 kms . from India's commercial capital of Mumbai, in 1994 and expanded in 1999. The facility at present manufactures $32,000 \mathrm{MT}$. of Rods, $50,500 \mathrm{MT}$. of AAC, AAAC and ACSR Conductors and $11,500 \mathrm{kms}$. of Power, Control and Aerial Bunch Cables. The key equipments are:

- Two oil fired furnaces with a capacity of 20 MT . each integrated with onl ine solution heat treatment plant \& Rod mill
- 10 very high speed fully Automatic Wire Drawing Machines
- 10 stranding machines of $1+6$ strands and 12 of multi strands including 3 lines facility to make 61 and 91 stranding conductors for EHV applications in one process
- The Cables division is equipped with 3 extrusion machines, 2 laying machines \& other allied machines
- Five DG sets of 625 KVA , Two DG sets of 500 KVA and Three DG sets of 1025 KVA for back-up purposes


## Quality Policy

We firmly believe that quality leads to customer delight, which is why we have developed stringent quality measures and standards. DPLL implements a structured Quality Policy with well-defined objectives and goals.

## Quality Objectives

- Maintaining consistency in product attributes, timely delivery, and services
- Encouraging participation of employees in improving quality and efficiency
- Safe and healthy work environments and optimized utilization of energy resources
- Continual employee training



## Quality Certifications

Third party validation of products is a significant way of measuring quality in the market place. Our products have been type tested at:
a. Central Power Research Institute, Bangalore
b. Electrical Research and Development Association, Vadodara
c. TAG Corporation, Chennai
d. Govt. Testing Laboratory, Govt. of Haryana
e. Bureau of Indian Standards labs
f. CEPRI, China
g. SABS, South Africa


## CONVERSION FACTORS AND FORMULAE

CONVERSION FACTORS TABLE
These units

| Amperes per sq. cm | 6.452 | Amperes per sq. in |
| :---: | :---: | :---: |
| Ampere-turns | 1.257 | Gilbert |
| Ampere-turns per cm | 2.540 | Ampere-turns per in |
| British thermal units | $\begin{aligned} & 778.3 \\ & 3.930 \times 10^{-6} \\ & 1.055 \\ & 2.931 \times 10^{-4} \end{aligned}$ | Foot pounds Horsepower hours Joules Kilowatt hours |
| B.tu. per min | $\begin{aligned} & 12.97 \\ & 0.02357 \\ & 0.01758 \\ & 17.58 \end{aligned}$ | Foot-pounds per sec <br> Horsepower <br> Kilowatts <br> Watts |
| Centimeters | $\begin{aligned} & 3.281 \times 10^{2} \\ & 0.3937 \\ & 6.214 \times 10^{6} \\ & 393.7 \\ & 1.094 \times 10^{2} \end{aligned}$ | Feet Inches Miles Miles Yards |
| Centimeter-dynes | $7.376 \times 10^{8}$ | Pound-feet |
| Centimeter-grams | $7.233 \times 10^{5}$ | Pound-feet |
| Centimeter per sec | $\begin{aligned} & 1.969 \\ & 0.03281 \\ & 0.02237 \\ & 3.728 \times 10^{-4} \end{aligned}$ | Feet per minute <br> Feet per sec <br> Miles per hour <br> Miles per minute |
| Circular mils | $\begin{aligned} & 7.854 \times 10^{7} \\ & 0.7854 \end{aligned}$ | Sq. inches <br> Sq. mils |
| Cms Per sec Per sec | 0.03281 | Feet per sec Per sec |
| Cubic Centimeters | $\begin{aligned} & 3.531 \times 10^{-5} \\ & 3.102 \times 10^{2} \end{aligned}$ | Cubic feet Cubic inches |
| Cubic feet | $\begin{aligned} & 7.481 \\ & 59.83 \\ & 29.92 \\ & 49.83 \\ & 24.915 \end{aligned}$ | Gallons U.S./6. 228 imp . gal <br> Pints (liquid) US <br> Quarts (liquid) US <br> Pints (imperial) <br> Quarts (imperial) |
| Cubic meters | $\begin{aligned} & 35.31 \\ & 61.024 \times 10^{3} \\ & 1.308 \\ & 264.2 \\ & 2113 \\ & 1057 \end{aligned}$ | Cubic feet Cubic inches Cubic yards Gallons US (1,759 imperial) pints (liquid) (879 imperial) quarts (liquid) |
| Degrees (angle) | 0.01745 | Radians |
| Degrees persec | 0.1667 | Revolutions per minute |
| Dynes | $2.248 \times 10^{-6}$ | Pounds |
| Ergs (dyne-Centimeters) | $\begin{aligned} & 9.480 \times 10^{-11} \\ & 7.378 \times 10^{-6} \\ & 10^{7} \end{aligned}$ | British thermal units <br> Foot pounds <br> Joules |
| Ergs per sec | $\begin{aligned} & 5.688 \times 10^{9} \\ & 4.427 \times 10^{-6} \\ & 7.378 \times 10^{-6} \\ & 1.341 \times 10^{-10} \\ & 10^{-10} \end{aligned}$ | B.t. units per minute Foot-pounds per minute Foot-pounds per sec Horsepower Kilowatts |
| Feet of Water | $\begin{aligned} & 62.43 \\ & 0.4335 \end{aligned}$ | Pounds per sq. foot Pounds per sq. inch |
| Feet per minute | $\begin{aligned} & 0.01667 \\ & 0.01136 \end{aligned}$ | Feet per seconds Miles per hour |
| Feet per sec | $\begin{aligned} & 0.5921 \\ & 0.6813 \end{aligned}$ | Knots <br> Miles per hour |


| These units | Multiplied by Equal |  |
| :---: | :---: | :---: |
| Foot-pounds | $\begin{aligned} & 1.285 \times 10^{3} \\ & 1.356 \times 10^{7} \\ & 5.050 \times 10^{7} \\ & 1.356 \\ & 3.766 \times 10^{7} \end{aligned}$ | British thermal units Ergs horsepower hours joules kilowatt hours |
| Foot-pounds per sec | $\begin{aligned} & 7.709 \times 10^{2} \\ & 1.818 \times 10^{3} \\ & 1.356 \times 10^{3} \end{aligned}$ | B.t. units per minute Horse power Kilowatts |
| Gallons U S | $\begin{aligned} & 0.1337 \\ & 231 \end{aligned}$ | Cubic feet Cubic inches |
| Gallons per minute | $2.228 \times 10^{3}$ | Cubic feet per sec |
| Gausses | 6.452 | Lines per sq. inch |
| Gilbert | 0.7958 | Ampere-turns |
| Gilbert per centimeter | 2.021. | Ampere-turns per inch |
| Grams | $\begin{aligned} & 980.7 \\ & 15.43 \\ & 0.03527 \end{aligned}$ | Dynes Grains Ounces |
| Grams | $\begin{aligned} & 0.03215 \\ & 2.205 \times 10^{\circ} \end{aligned}$ | Ounces (troy) <br> Pounds |
| Horsepower | 42.42 <br> 33,000 <br> 550 <br> 1.014 <br> 0.7457 <br> 745.7 | B.t. units per minute Foot-pounds per minute Foot-pounds per second Horsepower (metric). Kilowatts. Watts. |
| Horsepower (boiler) | $\begin{aligned} & 33.250 \\ & 9.804 \end{aligned}$ | B.t.u. per hour. Kilowatts. |
| Horsepower hours | $\begin{aligned} & 2,545 \\ & 1.98 \times 10^{6} \\ & 2.684 \times 10^{\circ} \end{aligned}$ | B.t. units Foot-Pounds Joules. |
| Inches of water | $\begin{aligned} & 0.5781 \\ & 5.202 \\ & 0.03613 \end{aligned}$ | Ounce per sq. in. Pounds per sq. ft . Pounds per sq. in. |
| Inches of water | $\begin{aligned} & 0.5781 \\ & 5.202 \\ & 0.03613 \end{aligned}$ | Ounces per sq. in. Pounds per sq. ft. Pounds per sq. in. |
| Joules ( lnt .) | $\begin{aligned} & 9.480 \times 10^{-1} \\ & 10^{\prime} \\ & 0.7378 \\ & 2.778 \times 10^{-1} \end{aligned}$ | B.t. Units <br> Ergs <br> Foot-pounds. <br> Watt-hours. |
| Kilograms | $\begin{aligned} & 980.665 \times 10^{-3} \\ & 2.205 \\ & 1.102 \times 10^{-2} \end{aligned}$ | Dynes. <br> Pounds <br> Tons (short) |
| Kilogram per sq. mm. | $\begin{aligned} & 14.223 \\ & 0.0063497 \end{aligned}$ | Pounds per sq. inch. Tons per sq. inch. |
| Kilogram per sq. mm. | 1,422.3 | Pounds per sq. inch. |
| Kilometer | $\begin{aligned} & 0.62137 \\ & 1,093.61 \\ & 3,280.84 \end{aligned}$ | Miles. Yds Ft. |
| Kilolines | $10^{3}$ | Maxvells |
| Kilowatts | $\begin{aligned} & 56.88 \\ & 4.427 \times 10^{4} \\ & 737.8 \\ & 1,341 \\ & 10^{9} \end{aligned}$ | B.t. units per min Foot-pounds per min. Foot pounds per sec. Horsepower Watts. |


To Convert Multiply by
LENGTH
Milli-inches into micrometers ..... 25.4
inches into millimetres ..... 25.4
Inches into centimetres ..... 2.54
Inches into metres ..... 0.0254
Feet into millimetres ..... 304 .8
Feet into centimetres ..... 30 .48
Feet into metres ..... 0.3048
Yards into metres ..... 0.9144
Fathoms into metres. ..... 1.8288
Chains into metres ..... 20.1168
Furlongs into metres. ..... 201.168
Miles, statute into kilometres ..... 1.609344
Miles, nautical into kilometres .....  1.852
VOLUME \& CAPACITY
Cubic inches into cubic centimetres ..... 16.387064
Cubic inches into litres ..... 0 .016387
Cubic feet into cubic metres ..... 0.0283168
Cubic feet into litres ..... 28.316847
Pints into litres ..... 0.5682613
Quarts into litres ..... 1.1365225
Cubic yards into cubic metres ..... 0.7645549
Gallons into litres ..... 4.54609
Gallons into cubic metres ..... 0.0045461
Fluid ounces into cubic centimetres ..... 28.413063
AREA
Square inches into square millimetres ..... 645.16
Square inches into square centimetres ..... 6.4516
Square feet into square centimetres ..... 929.0304
Square feet into square metres .....  0.092903
Square yards into square metres ..... 0 .836123
Acres into ares 40.468564
Acres into hectares. ..... 0.4046856
Square miles into hectares ..... 258.9988
Square miles into square kilometres ..... 2.589988
To Convert Multiply by
MASS
Grains into milligrams ..... 64.79891
Grains into metric carats ..... 0.323995
Grains into grams ..... 0.064799
Penny weights into grams ..... 1 .555174
Drams into grams .....  1.77185
Ounces into grams ..... 28.349523
Ounces troy into grams ..... 31.103477
Ounces troy into metric carats ..... 155 .5174
Ounces into kilograms. ..... 0.0283495
Pounds into kilograms ..... 0.4535924
Stones into kilograms ..... 6.3502932
Hundred weights into kilograms ..... 50.802345
Tons into kilograms ..... 1016.0469
Tons into metric tonnes ..... 1.01604
Tahils into grams .....  37.799
Kati into kilograms ..... 0.60479
POWER
Foot pounds-force per second into watts ..... 1.35582
Horsepower into watts ..... 745 .7
Foot pounds-force per second into kilowatts ..... 0.001356
Horsepower into kilowatts .....  0.7457
Horsepower into metric horsepower ..... 1.01387
$1 \mathrm{Kgf}=9.81 \mathrm{~N}$
$1 \mathrm{~N}=0.1019 \mathrm{~kg}$$1 \mathrm{KN}=0.1019 \times 1000$

## VARIOUS TYPES OF CONDUCTORS

## VARIOUS TYPES OF CONDUCTORS

## TYPES

The most innovative and revolutionary new technical concept has now taken concrete shape in the form of 'Aluminium Alloy Conductor' in the "Transmission and distribution field" a most effective break through for energy conservation through improved conductordesign.
Aluminium Alloy Conductor is a Generic name. The group generally includes AAAC-HS, AAC-HC, ACAR, AACSR, ABC etc.
Aluminium Alloy Conductors have been in use for over last four decades in most of the developing countries for overhead transmission lines, particularly for extra high voltage and high voltage transmission ranging from 66 kV to 400 kV voltage class transmission and in coastal areas. Even for distribution voltage class of 33 kV and 11 kV AAAC conductors have been proving technically most successful and superior to AAC and ACSR conductors.

## AAAC-HS

AAAC-HS comprises heat treatable Aluminium Alloy wires like AA 6201 (IS designation 64401) with UTS higher than $30 \mathrm{~kg} / \mathrm{mm}^{2}$, elongation more than 4\% and conducting higher than 52.5\%.

## AAAC. HC

AAAC-HC comprises that treatable over aged Alloy wires like AA6201 (IS designation 64401) or of non heat treatable alloy wires like AA 5005 (IS designation 51000 A), Ductalex EEE etc., with UTS ranging between $20-25 \mathrm{~kg} / \mathrm{mm}^{2}$, elongation between $2 \%$ to $4 \%$ and conductivity ranging between $56 \%$ to $59 \%$.

## ACAR: (Aluminium Conductor Alloy Reinforced)

ACAR comprises EC grade Aluminium wires and high strength Aluminium Alloy wires with adequate mechanical strength and overall electrical conductivity between $56 \%$ to $60 \%$.

## AACSR: (Aluminium Alloy Conductor Steel Reinforced)

AACSR comprises high strength Aluminium Alloy wires reinforced with high tensile galvanized steel core with very high mechanical strength and adequate electrical conductivity.

## $A B C$ : (Aerial Bunched Cables)

ABC comprises compacted, bare / insulated high strength Aluminium Alloy conductor as a neutral messenger wire bunched with three to five insulated EC grade Aluminium phase conductors and lighting conductors.

The typical data sheets covering basic properties of above types are put-up here with as Annexure ' $A$ '.
For the above data sheets, it can be said that Tensile strength of drawn Aluminium Alloy wire is about two times more than that of EC aluminium wires. It is therefore the Alloy conductors, which are free from steel core, are about 25\% lighter than ACSR conductors of equivalent strength.
Because of low strength weight ratio of new conductors for specific value of sag, it is possible to increase the length of span, resulting in reduction in number of towers and hardware.
The electrical conductivity of Alloy conductor is about $10 \%$ higher than the equivalent ACSR conductor. Moreover because of elimination of steel core wires, there is no magnetic and eddy current effect resulting in low line loss.
Alloy Rod has high ductility, which enables it to draw in fine size wires.
Alloy conductors have high resistance to corrosion, which impart much more life as compared to ACSR and are particularly useful in severe marine, industrial and tropical environment.

Alloy strands have surface hardness twice that of EC grade Aluminium strands thereby having high abrasion resistance and better surface finish resulting in low corona loss, less radio interference (RIV), better performance undertension and compression.

Alloy strands have high creep resistance, high fatigue resistance and superior structural stability even at varying temperature.
For production of conductor alloy, even high silicon content Aluminium with controlled impurities, which is largely available in India may be used.
Alloy suitable for Aluminium conductors belongs to AL-MG- Si system with varied composition. The most commonly adopted alloy in the country designated as 6201 has following nominal percentage of composition as per IS 9997 / 1991 (First Revision) with other technical parameters are given at Annexure 'B' for mechanical and electrical properties.

## ACSR CONDUCTORS

The Aluminium conductors galvanized steel reinforced briefly called as ACSR comprises of seven or more Aluminium and galvanized steel wires, built up in concentric layers. The Centre wire or wires are of galvanized steel and the outer layer or layers are of Aluminium. As such steel cored. Aluminium conductors have been widely adopted for high voltage transmission lines specially for long spans. It has high tensile strength but it reduces with rise of temperature above $65^{\circ} \mathrm{C}$.

There are many types of such composite conductors which are covered in IS 398 (P II) / 1976-1996, BS 0215 (P II) / 1970 and other international standards.

The conductivity of steel cored Aluminium conductor is taken as that of Aluminium portion alone as the steel wires have high resistance to alternating currents.
The strength is taken as 85 percent of the sum of steel wires plus $95 \%$ of the sum of the strength of the Aluminium wires. The factor $85 \%$ and $95 \%$ allows for the stranding. The strength of Aluminium wires varies from 23000 lb . per sq. inch (for larger wires) to 28000 lb . per sq. . inch (for small wires) and of steel from $179000 \mathrm{lb}, / \mathrm{in}^{2}$ to $200000 \mathrm{lb}, / \mathrm{in}^{2}$. The total strength of steel cored Aluminium conductor is normally $50 \%$ greater than that of equivalent copper conductors. And the weight only three quarters as much (one half due to Aluminium and a quarter to steel). It is claimed that the result is a conductor with smaller ratio of loading to strength than any other conductor, even allowing for increased wind and ice loads due to the increased diameter as compared with that of the equivalent copper conductor. The sag is therefore the least so that supporting towers may be shorter or the span length greater for given sag than for any other conductor. The larger diameter is useful in very high voltage lines as the corona losses are less.
ANNEXURE ' A '
AAAC-HS BASIC PROPERTIESULTIMATE TENSILE STRENGTH ( $\mathrm{kg} / \mathrm{mm}^{2}$ )
Minimum Average ..... 30.00
Typical
Wire Diameter Range (mm)
From 1.19 upto 3.30 ..... 32.7
Above 3.30 upto 3.80 ..... 32.0
Above 3.80 upto 4.30 ..... 31.3
ULTIMATE ELONGATION (percent in 200 mm )
Minimum ..... 4.0
Typical5.5
MODULI OF ELASTICITY (kg/mm²)
Initial modulus (average) ..... 5200 to 5600
Final modulus (average)
6250 to 64500.00360
TEMPERATURE COEFFICIENT OF$23 \times 10^{6}$
TEMPERATURE COEFFICIENT OF LINEAR
EXPANSION per ${ }^{\circ} \mathrm{C}$ (Between 10 and $100^{\circ} \mathrm{C}$ )CREEP (10 year typical)0.05\%
BRINELL HARDNESS (BHN)80
ELECTRICAL VOL. RESISTIVITY at$20^{\circ} \mathrm{C}\left(\Omega-\mathrm{mm}^{2} / \mathrm{m}\right)$
Standard ..... 0.0325
Typical ..... 0.0320
SPECIFIC WEIGHT (gram / cubic centimeters) ..... 2.70
ELECTRICAL CONDUCTIVITY at $20^{\circ} \mathrm{C}$ (\% IACS)Standard52.5
Typical ..... 53.3
AAAC.HS TECHNICALADVANTAGES
(Over Electro-Mechanically EquivalentACSR)
MECHANICAL STRENGTH TO WEIGHT ratio is sufficienthigh to avoid steel core, hence:

- Light conductors
- Smaller tension, smaller loads on angle and dead end towers
-Easier handling and transportation on site.
- Homogeneous conductors:
- Even distribution of stresses across the section.
- Smaller gyration, easier running out under tension
- Simpler, safer and economical joints
- Higher value of scrap
SURFACE HARDNESS twice that of Aluminium strands, hence:- Less prone to damage and scratches during running out- Smaller corona losses and radio interference- Better performance under splicing and compression- Greater reliability in service, easier erection
CHEMICAL RESISTANCE- In AAAC, absence of steel / zinc / Aluminium cell hence
- Better corrosion resistance in sea coast or industrial areas
ELONGATION almost equal to that of steel (4\%)
-In AACSR, for lines in mountains and estuaries:
- Excellent mechanical homogeneous


## MANUFACTURING PROCESS OF AAAC \& ACSR

## MANUFACTURING PROCESS OF AAAC \& ACSR

## ALL ALUMINIUM ALLOY CONDUCTOR (AAAC)

Manufacturing process involves special Thermo-mechanical treatment to obtain the desired properties of conductor. There are two methods generally adopted (1) Almelec process of France and (2) Aldrey process of Germany. In Almelec process of Alloy rod ( 9.5 mm ) is drawn to the intermediate size ( 6.7 mm diameter and thereafter it is solution treated. The wire is then redrawn to the required size which is finally aged and stranded. Whereas in Aldrey process, the alloy rod is initially solution treated and thereafter directly drawn to required size and finally aged to obtain the desired properties.

## SOLUTION TREATMENT

Solution treatment is the process by which super-saturated solid solution of Alloy structure is produced to take advantages of its precipitation hardening characteristics.
Alloy rod ( 9.5 mm diameter) in coil is drawn to 6 mm intermediate wire drawing and charged in a large electrically heat and air circulated solution treatment furnace at a temperature of 535 degree centigrade ( $\pm 5 \%$ ) with boiling time of 45 to 60 minutes thereafter immediately (within 30 sec ) quenched in water (at room temperature). The coil is then rinsed to dry the surface of the rod completely.
The solutionised rod has to be drawn within 24-72 hours after solution treatment otherwise the rod will become harder due to natural aging and there will be difficulty in drawing operation.

## DRAWING

Aluminium Alloy rod can well be drawn in slip type wire drawing machine having hardened and ground capstans with 450 mm minimum diameter arranged in line. Capstans, dyes and wires are submerged in lubricant. In addition, fresh, cool lubricant is sprayed under pressure into the dye approach thus additionally increasing the coming lubricating and cleaning effect. The winding unit should have provision for cooling and separately driven by Torque motor or Eddy Current drive having taper tension characteristics.
While tapered drafting is adopted for copper, constant drafting procedure is adopted for EC grade Aluminium (constant 25\% elongation per dye) and Alloys (constant $20 \%$ elongation per dye).

## AGING TREATMENT

Artificial aging is the heat treatment to stabilize the structure of Alloy wire at desired hard ness.
This drawn wire accommodated in the perforated bobbins and coils is changed in electrically heated furnace at a period of 4-5 hours at temperature of 150 to 165 degree centigrade for further aging of the wire.
The correct aging time and temperature will have to be established by actual practice to achieve the desired properties of the strands.

## STRANDING

Stranding of finally drawn and aged wire are ideally done on floating type stranding but conventional rigid type tandem wire stranding machines having provision for pre-forming and post forming arrangement, with special measures such as proper tensioning and largest possible radius of curvature of wires and stranded conductors are normally used for high productivity.

## TESTING <br> TYPE TESTS:

The following test shall be conducted once on a sample / samples of conductor to every 750 kms of production from each manufacturing facility:
a. UTS Test On Stranded Conductor
b. Corona Extinction Voltage Test (Dry)
c. DC Resistance Test On Stranded Conductor

## ACCEPTANCETESTS:

a. Visual and dimensional check on drum
b. Visual check for joints scratches etc. and lengths of conductors by rewind ing
c. Dimensional check on steel and Aluminium strands
d. Check for lay ratios of various layers
e. Breaking load test on Aluminium strands
f. Wrapteston Aluminium strands
g. DC resistance test on Aluminium strands
h. Procedure qualification test on welded joint of Aluminium strands

Note: All the above tests except (h) shall be carried out on Aluminium Alloy Strands after standing only.

ROUTINE TESTS:
a. Check to ensure that the joints are as per specifications
b. Check that there are no cuts, fins, etc. on the strands
c. Check that drums are as per specifications
d. All acceptance tests as mentioned above, to be carried out on each coil

## PROCESS FLOW CHART-AAA CONDUCTOR



QUALITY ASSURANCE PLAN FOR AAA CONDUCTOR MANUFACTURING AT DIAMOND POWER INFRASTRUCTURE LIMITED

| Sr. | Components \& Operation | Characteristics | Type of Check | Reference Documents | Quantum <br> Of Check | Acceptance Norms | Format Of Record | Agency |
| :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: |
| A | Raw Material Testing All Aluminium Alloy | (a) Dimension (diameter) <br> (b) Tensile <br> Strength <br> (c) \% of <br> Elongation <br> (d) Resistance / <br> Resistivity conductivity | Measurement <br> Mechanical <br> Mechanical <br> Electrical | IS-9997-1991 | 100\% | As given in \|S-9997-1991 | Raw material analysis register and test certificate | $\begin{aligned} & \text { Inspection and } \\ & \text { quality control } \\ & \text { department } \end{aligned}$ |
| B | In Process Testing <br> Testing of Rod: Before Solution Treatment | (a) Dimension (diameter) <br> (b) Tensile <br> Strength <br> (c) $\%$ of <br> Elongation <br> (d) Resistance / <br> Resistivity conductivity | Measurement <br> Mechanical <br> Mechanical <br> Electrical | Standard process documents | 100\% |  | Process Inspection Register | Internal testing by QA Inspector |
| C | Testing of Rod: After Solution Treatment | (a) Dimension (diameter) <br> (b) Tensile <br> Strength <br> (c) \% of <br> Elongation <br> (d) Resistance / <br> Resistivity <br> conductivity | Measurement <br> Mechanical <br> Mechanical <br> Electrical | - | 100\% | Register | Process <br> Inspection |  |
| D | Testing of Rod: Before Ageing Test (lot) | (a) Dimension (diameter) (b) Tensile Strength (c) $\%$ of Elongation <br> (d) Resistance | Measurement <br> Mechanical <br> Mechanical <br> Electrical | $\begin{aligned} & \text { IS-398 } \\ & \text { Part-IV } 1994 \end{aligned}$ | 100\% |  |  | QA Inspection |
| E | Testing of Rod: After Aging Test (lot) | (a) Dimension (diameter) <br> (b) Tensile <br> Strength <br> (c) \% of <br> Elongation <br> (d) Resistance <br> (e) Surface finish | Measurement <br> Mechanical <br> Mechanical <br> Electrical Visual | $\begin{aligned} & \text { IS-398 Part-IV } \\ & 1994 \end{aligned}$ | 100\% | IS-9997-1991 |  | QA Inspection |
| F | Stranding | (1) Diameter <br> (2) Direction <br> (3) Lay Ratio <br> (4) Surface finish | Measurement Visual <br> Measurement Visual | $\begin{aligned} & \text { IS-398 Part-IV } \\ & 1994 \end{aligned}$ | Each <br> Length Every Drum | $\begin{aligned} & \text { As given in } \\ & \text { IS-398 Part-IV } \\ & 1994 \end{aligned}$ | Lay Ratio Chart | QA Inspection |
| G | Finish Conductor Testing | Measurement <br> (a) Lay Ratio <br> (b) Diameter <br> (c) Breaking Load <br> (d) \% of <br> Elongation <br> (e) Resistance | Measurement Measurement Measurement Measurement Measurement <br> Electrical | $\begin{aligned} & \text { IS-398 Part-IV } \\ & 1994 \end{aligned}$ | 100\% | $\begin{aligned} & \text { As given in } \\ & \text { IS-398 Part-IV } \\ & 1994 \end{aligned}$ | Type Test Report \& Test Certificate | Inspection \& QC department counter checked by third party \& BIS |

## ALUMINIUM CONDUCTOR STEEL REINFORCED (ACSR)

## WIRE DRAWING OPERATION:

9.5 mm Diameter EC Grade Aluminium Rod is tested for surface finish, Diameter, Elongation, Resistivity Test etc.,' 'Qual ity OK' material will be taken for production. EC grade Aluminium rod is drawn into the required Diameter on Wet Type Wire Drawing Machine and it undergoes test like Elongation, Breaking Load, Resistance, Diameter Surface Finish, Wrapping Testetc.

## SPOOLING OPERATION:

HTGS wires are tested for Diameter, Surface Finish Elongation, Breaking Load, Dip Test, Torsion etc., as per relevant IS standard. 'Quality OK' material undergoes to spool ing operation.

## STRANDING OPERATION:

In case of small conductors i.e. conductors not having more than seven strands, center wire to HTGS wire will be stranded with six wires of Aluminium on Tubular Machine.

In case of multi layer conductor, seven HTGS wire are stranded on Tubular Machine and the same stranded conductor is again stranded with Aluminium wires on Multi Strand Machine in a required Wooden Drum. Packing and stenciling will be done as per IS 398 Part-II, 1996.

## QUALITY ASSURANCE PLAN FOR ACSR CONDUCTORS

| Sr. <br> No. | Components \& Operation | Characteristics | Type of Check | Reference Documents Check | Quantum of Check | Acceptance Norms | Format of Record | Agency |
| :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: |
| 1. | Aluminium Rods | (a) Diameter <br> (b) Tensile Strength <br> (c) Conductivity | Measurement Physical Electrical | IS-398 Part-II | 100\% | As given in IS398 Part-ll 1996 | Raw material Analysis Registration | Inspection \& QC department |
| 2. | Wire Drawing | (a) Diameter | Measurement Physical Electrical | IS-398 Part-11 | 100\% | As given in IS398 Part-II 1996 | $\begin{aligned} & \text { Process } \\ & \text { Control } \\ & \text { Forms } \\ & \hline \end{aligned}$ | Inspection \& QC department |
| 3. | Stranding | (a) Lay Ratio <br> (b) Surface Check <br> (c) Resistance | Measurement <br> Visual <br> Electrical | IS-398 Part-II | 100\% | As given in IS398 Part-II 1996 | Process Control Forms | QC Inspection \& Production Supervisor |
| 4. | Galvanized Steel Wires | (a) Diameter <br> (b) Mass of Zinc coating <br> (c) Dip Test <br> (d) Torsion Test <br> (e) Elongation Test <br> (f) Wrapping Test <br> (g) Lay Ratio | Measurement Chemical <br> Chemical <br> Physical <br> Physical <br> Physical measurement | IS:4826 IS:4826 IS:398 Part-II IS:398 Part-II IS:398 Part.ll IS:398 Part-II | 10\% | As given in IS398 Part-ll 1996 | Process Control Forms \& Raw material Analysis Register | Inspection \& QC department |
| 5. | Finished Conductor | Test on Aluminium <br> (a) Diameter <br> (b) Breaking Load <br> (c) Lay Ratio <br> (d) Resistance | Measurement Physical Measurement Electrical | IS:398 Part-Il IS:398 Part-Il IS:398 Part.II IS:398 Part-II | 100\% | As given in IS398 Part.\|l 1996 | ISI Records and Test Certificates | Inspection, QC department \& Customer Representative |
| 6. | Finished Conductor | Test on GI Wire <br> (a) Diameter <br> (b) Breaking Load <br> (c) Lay Ratio <br> (d) Mass of Zinc coating <br> (e) Dip Test <br> (f) Elongation <br> (g) Wrapping | Measurement <br> Physical <br> Measurement <br> Chemical <br> Chemical <br> Physical <br> Physical | IS:398 Part-11 IS:398 Part.II IS:398 Part-II IS:4826 IS:398 Part-ll IS:4826 IS:398 Part-II IS:398 Part-II | 100\% | As given in IS:4826 As given in IS:398 P-II 1996 As giben in IS:398 P-II 1996 | Supplier's certificates are kept in record and randomly checked in QC department \& register is maintained | Inspection, QC department \& Customer Representative. Counter checked by BIS representative |

PROCESS FLOW CHART - ACSR CONDUCTOR


## COMPARISON OF AAAC \& ACSR

## COMPARISON OF AAAC WITH ACSR

| AAAC | ACSR |
| :---: | :---: |
| Aluminium alloy conductor is revolutionary break-through in conductor technology. Users all over the world are switching over to $A A A C$ due to its technical superiority. | Aluminium conductor steel reinforced is outdated in technology. Its use is obsolete in developed countries due to technical and economical shortcomings. |
| Heat-treated AI-Mg-Si alloy makes AAAC totally free from bimetallic corrosion and exceptionally resistant to environmental corrosion. | In ACSR, corrosion (bi-metallic and environmental) because of steel core sets in within 2 years, lowering efficiency. |
| Service life is around 60 years-twice as durable as ACSR. | Service life ranges between $15-30$ years. Particularly less in industrial and sea line atmospheres. |
| Hard to cut and impossible to recycle into utensils. Excellent inhibitor of theft, eliminating unwanted power breakdowns. | Easily cut and recycled overnight for making utensils. Stolen ACSR till date adds up to Rs. 100 crores even by conservative estimates. |
| $\mathrm{A} A \mathrm{AC}$ has higher strength to weight ratio ranging between 10.6: 11.6 on an equal diameter basis. Offers savings due to reduction in number of towers, foundations and accessories. | ACSR has lower strength to weight ratio ranging between 88.4:9.4; hence requires lesser spans than $A A A C$. Lower cost of ACSR is offset due to higher cost of towers etc. |
| Suffers no reduction in strength on temperature rise upto $90^{\circ} \mathrm{C}$ since it is specially heat treated at $160^{\circ} \mathrm{C}$ temp. Can be loaded to higher level of capacity. | Strength of ACSR reduces with rise in temperature above $65^{\circ} \mathrm{C}$. Not suitable for overloading. |
| No steel core means, no magnetic losses. Thus zero additional line losses due to electromagnetic effect. | Steel core induces eddy current and hysteresis losses. |
| Repair and replacing, dead ending is easier because AAAC is monometal lic. Ordinary fitting and accessories without steel inserts can be used. Works out to be economical in the long run. | Repairs are time consuming and frequent, requiring special procedures. Maintenance costs and inherent defects make it costlier in the long run. |

Many other Advantages are also claimed for AAAC as listed below:
\(\left.\begin{array}{ll}Lesser stretch \& AAAC stretches much less than AAC (All Aluminium Conductor) and less <br>
than ACSR under normal operating tension. <br>
Higher Ampacity \& AAC when compared to ACSR size, possess about 10\% higher <br>
conductivity. In other words, for equal temperature rise, AAAC can carry <br>

10 \% extra current on the line.\end{array}\right\}\)| AAAC stranded overhead conductors when subjected to static tensile |
| :--- |
| Higher creep resistance |
| stresses for a long period of time, have relatively smaller increase in sag. |

## 1. Characteristics of All Aluminium Alloy Conductor

1. AAAC alloy 6201 is claimed to have better corrosion resistance and better strength to weight ratio and improved electrical conductivity than ACSR on an equal diameter basis. This makes the AAAC better suited in corrosive areas like sea coast and industrial areas where high metallic corrosion sets in. The higher strength to weight ratio facilitates lesser sags on larger spans.
2. Advantages of $A A A C$
3. Compatible thermal stability: AAAC can perform at $90^{\circ} \mathrm{C}$ continuously for a period of one year literally with no loss of strength and it can operate safely at $150^{\circ} \mathrm{C}$ for 3 hours. Under short circuit conditions, temperatures upto $200^{\circ} \mathrm{C}$ for 0.5 Seconds can be easily withstood.
4. Ease of repair: AAAC being monometallic in construction lends itself to easy repairs, splicing and dead-ending. It is claimed that there is a saving of about 50\% time. Reduction of cost of work at site is about 20 to $25 \%$
5. Corrosion Resistance: Almelec AAAC exhibits excellent corrosion resistance in corrosive atmospheres like industrial areas.

However, laboratory tests at CPRI indicate that all Aluminium alloy materials are prone to marine corrosion in chloride atmospheres (pitting corrosion). Resistance to this marine corrosion has been investigated at CPRI and it has been found that a coating of zinc on the individual strands of the conductor will improve the life of the conductor as a whole. The zinc coating does not effect other properties of materials.

Of course there is no possibility of galvanic corrosion since the material is not bimetallic.

## 3. Power Saving Capability of AAAC:

1. The power saving by use of $A A A C$ was quantified by CPRI. The details are enumerated in the ensuing paragraphs.
2. The saving in power results from lower resistance of $A A A C$ compared to that of $A C S R$ conductor for equal conductor diameter. The resistances pertaining to AAAC conductors are those furnished by the manufacturers. For ACSR conductors the resistance have been computed using the standard hand book (Wasting Hose Fourth U.S. Edition Oxford and IBH Publishing Corporation) and suitably extrapolating to match the size to conductor used in our country. Table 2 shows the resistance value of a few commonly used ACSR conductors and their AAAC equivalents.
3. Futher, the percentage reduction in losses by use of $A A A C$ as substitute for $A C S R$ conductor has been computed in two ways.
i. Considering a hypothetical 100 km line loaded to its full capacity i.e. 92A, 122A. \& 180 A for Weasel, Rabbit and Dog ACSR conductors and their AAAC equivalent respectively.
ii. Taking a practical system with typical loading and applying ACSR and its equivalents AAAC conductors, for calculating energy loss, loss load factor was used (LLF + ) $0.2 \times L F+0.8 \times L F^{2}$ ). A diversity factor of 1.5 was assumed for the loads. The practical feeder, considered is enclosed at Annexure-II, system details are at Annexure-III.
4. The findings pertaining to the hypothetical system is given in Table 3. Calculations are given in Appendix-l.
5. Similar results for practical system are show in Table 4, The load factor was varied from 0.4 to 1.0 to study the dependence of economy on load factors. The details of calculations are appended in Appendix-IV.
6. Observations: it can be seen from Table 3 that the savings in peak load power loss by use of AAAC equivalent conductors varies between $12 \%$ and $14.5 \%$ depending on the type of conductor considered.
In a practical system percentage saving in peak load power loss was found to be about $16.3 \%$ (See Table 4 ) Under these conditions, the savings in annual capitalised cost due to lower energy loss with AAAC is found to vary from $2.5 \%$ at a load factor of 0.4 to $11.2 \%$ at a load factor 1 . The other advantages claimed for AAAC can be verified only after obtaining the feed back from the field after long time use.

## 4. Conclusion

1. AAAC is superior to ACSR conductors when used in overhead distribution system,
2. The increased cost of $A A A C$ (claimed to be $15 \%$ to $20 \%$ costlier than corresponding ACSR conductors) is offset by the saving in power loss.
3. Other advantages of AAAC are better thermal stability, ease of repair, corrosion resistance, longer service life, less prone to pilferage as known through literature.

TABLE - 1 TYPES OF ALUMINIUM ALLOY CONDUCTORS

| Alloy | Country | Standard |
| :--- | :--- | :--- |
| 6201 | U.S.A. | ASTM-B-398 |
| ALMELEC (AGS) | France | NEC-34125 |
| SILMALEC (E91E) | U.K. | BS-1470-1477 |
| ALDREY | Germany | DIN 48200 |
| ALDREY | Switzerland | ASE 021 |
| ALMELEC | Italy | UNI 3570 |
| IGO | Japan | JEC 74 |
| ALMELEC (AAAC) -1979 | India | IS: (PART-IV) 1979 |
| ALUMINIUM ALLOY STRANDED CONDUCTOR (A1 MgSi type) | IEC | Recommendation No. 208 |

TABLE - 2 RESISTANCE OF ACSR AND AAAC EQUIVALENT CONDUCTORS

| Conductor |  | AC resistance @ 50 Hz, <br> $50^{\circ} \mathrm{C}$ per km in $\Omega$ |
| :---: | :---: | :---: |
| Type | Code name |  |
| ACSR | Weasel | 0.9620 |
| AAAC | Equiv. | 0.6792 |
| ACSR | Rabbit | 0.5751 |
| AAAC | Equiv. | 0.3600 |
| ACSR | Dog | 0.3080 |
| AAAC | Equiv. |  |

TABLE - 3 SAVINGS AS PERTAINING TO THE HYPOTHETICAL SYSTEM

| Type of conductor and code name |  | Peak load current | Peak load power loss | Energy loss annum per | Savings in energy loss | Savings |
| :---: | :---: | :---: | :---: | :---: | :---: | :---: |
| Type | Code Name | A | kW | Rs. Lakhs | Rs. Lakhs | \% |
| ACSR | Weasel | 92 | 2775 | 65.63 |  |  |
| AAAC | Equiv. | 92 | 2443 | 57.78 | 7.85 | 12 |
| ACSR | Rabbit | 122 | 3033 | 71.74 |  |  |
| AAAC | Equiv. | 122 | 2567 | 60.71 | 11.03 | 15.4 |
| ACSR | Dog | 180 | 3499 | 82.76 |  |  |
| AAAC | Equiv. | 180 | 2994 | 70.81 | 11.95 | 14.44 |
|  |  |  |  | $\mathrm{LF}=0.6$, | Rate per kwh | $=$ Rs. 0.45 |

TABLE - 4 ECONOMICS FOR THE PRACTICAL SYSTEM CONSIDERED
Rate per kWh Re. 1/.

| Sr. | Description | Type of | Load factor |  |  |  |  |  |  |
| :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: |
|  |  |  | 0.4 | 0.5 | 0.6 | 0.7 | 0.8 | 0.9 | 1.0 |
| 1. | Peak load losses <br> (kW) | ACSR | 11.8516.3 |  |  |  |  |  |  |
|  |  |  |  |  |  |  |  |  |  |
|  |  | AAAC Equiv. kW. |  |  |  |  |  |  |  |
| 2. | Savings in peak load losses | \% |  |  |  |  |  |  |  |
| 3. | Annual capitalized cost. (Rs.) | ACSR <br> AAAC <br> Equiv. | $\begin{aligned} & 296357 \\ & 288960 \end{aligned}$ | $\begin{aligned} & 354843 \\ & 337895 \end{aligned}$ | $\begin{aligned} & 423500 \\ & 395341 \end{aligned}$ | $\begin{array}{\|l\|} \hline 502328 \\ 461298 \\ \hline \end{array}$ | $\begin{aligned} & 591328 \\ & 535765 \end{aligned}$ | $\begin{aligned} & 690500 \\ & 612742 \end{aligned}$ | $\begin{array}{\|l\|} \hline 799842 \\ 710230 \end{array}$ |
| 4. | Savings in annual capitalised cost | Rs. $\%$ | $\begin{aligned} & 7397 \\ & 2.5 \\ & \hline \end{aligned}$ | $\begin{aligned} & 16948 \\ & 4.8 \\ & \hline \end{aligned}$ | $\begin{aligned} & 28159 \\ & 6.45 \\ & \hline \end{aligned}$ | $\begin{aligned} & 41030 \\ & 8.17 \\ & \hline \end{aligned}$ | $\begin{aligned} & 55563 \\ & 9.4 \\ & \hline \end{aligned}$ | $\begin{aligned} & 81758 \\ & 11.54 \end{aligned}$ | $\begin{aligned} & 89612 \\ & 11.2 \\ & \hline \end{aligned}$ |

## COMPARISON FOR WEASEL CONDUCTOR

a) AC resistance of ACSR Weasel Conductor

Weasel ACSR Conductor
Size: 6/1/0.102"
As per Hand Book
AC resistance of $6 / 1 / 0.102^{\prime \prime}$ standard ACSR conductor at 50 Hz and $50^{\circ} \mathrm{C}=1.66 \Omega /$ mile. AC resistance of Weasel Conductor (Extraporaled $=1.66 \times\left(0.1052^{2}\right) /\left(0.102^{2}=1.76 \Omega /\right.$ mile $=1000 \times 1.76 / 1609.344=1.0933 \Omega / \mathrm{km}$.
b) AC resistance of equivalent $A A A C$
$=0,9620 \Omega / \mathrm{km}$
c) Economy:

|  | ACSR Weasel | Equivalent AAAC |
| :--- | :--- | :--- |
| Peak load current (A) | 92 | 92 |
| AC resistance $(\Omega / \mathrm{km})$ | 1.093 | 0.9620 |
| Peak load losses for 100 km <br> length (3 $1^{2}$ R) | 2775 kw | 2443 kW |
| Energy loss per annum @ 0.6 LF <br> and Rs. $0.45 / \mathrm{kwh}$ (Rs. lakhs) | 65.63 | 57.78 |
| Savings in energy losses / annum <br> (Rs. lakhs) |  | $7.85(12 \%$ savings) |

## COMPARISON FOR RABBIT CONDUCTOR

a) AC resistance of ACSR Rabbit Conductor:

Size of Rabbit ACSR 6/1/3.35
$=6 / 1 / 0.1319^{\prime \prime}$
as per T \& D hand book
AC resistance of $6 / 1 / 0.1327^{\prime \prime}$ stranded ACSR conductor at 50 Hz and $50^{\circ} \mathrm{C}+\mathrm{C}=1,08 \Omega / \mathrm{mile}$.
AC resistance of Rabbit Conductor
Extrapolated $=1.08 \times\left(0.13227^{2}\right) /(0.139)^{2}=1.093 \Omega / \mathrm{mile}=1.093 \times 1000 / 1609.344=0.6792 \Omega / \mathrm{km}$.
b) AC resistance of equivalent AAAC
$=0.5751 \Omega / \mathrm{km}$
c) Economy

|  | ACSR Equivalent | AAAC Equivalent |
| :--- | :---: | :---: |
| Peak load current (A) | 122 A | 122 A |
| AC resistance $(\Omega / \mathrm{km})$ | 0.6792 | 0.5751 |
| Peak load losses for $100 \mathrm{~km}(\mathrm{kw})$ | 3.033 | 2.567 |
| Energy losses per annum @ 0.6 LF and Rs. $0.45 / \mathrm{kWh}$ <br> (in Rs. lakhs) | 71.74 | 60.7 |
| Savings in energy losses per annum <br> (Rs. lakhs) |  | $11.03(15.4 \%)$ |

## COMPARISON FOR DOG CONDUCTOR

a) $A C$ resistance of ACSR Dog Conductors:

Dog ACSR Conductor size $4.72 \times 6.7 \times 1.57=0.1858^{\prime \prime} \times 6.7 \times 0.80618^{\prime \prime}$
As per Hand Book
AC resistance of $6 \times 0.1878^{\prime \prime}$ stranded ACSR conductor at $50 \mathrm{H}_{2}$ and $50^{\circ} \mathrm{C}=\mathrm{C}=0.567 \Omega / \mathrm{mile}$.
AC resistance of Dog
Conductor $($ Extrapolated $)=0.567 \times\left(0.1878^{8}\right) /\left(0.1852^{2}\right)$
$=0.579 \Omega$ per mile
$=0.36 \Omega / \mathrm{km}$
b) AC resistance of equivalent $\mathrm{AAAC}-0.3080 \Omega / \mathrm{km}$
c) Economy

|  | ACSR Dog | AAAC equivalent |
| :--- | :---: | :---: |
| Peak load current (A) | 180 | 180 |
| AC resistance $(\Omega / \mathrm{km})$ | 0.36 | 0.3080 |
| Peak load losses for 100 km length (3 1 ${ }^{2}$ R) (kW) | 3499 | 2994 |
| Energy losses per annum @ 0.6 LF and Rs. $0.45 / \mathrm{kwh}$ (in lakhs) | 82.76 | 70.81 |
| Saving in energy |  | 11.95 |
| losses / annum (Rs. Lakhs) |  | $(14.44 \%)$ |

CONDUCTOR - ELECTRICAL CHARACTERISTICS AND COST DETAILS:

| Conductor <br> code | Type | Resistance per <br> $\mathrm{km}(\Omega)$ | Reactance per <br> $\mathrm{km}(\Omega)$ | Cost per km <br> (Rs.) |
| :---: | :---: | :---: | :---: | :---: |
| Rabbit | ACSR | 0.6792 | 0.372 | 41338 |
| Weasel | AAAC | 0.5751 | 0.372 | 47538 |
|  | ACSR | 1.093 | 0.382 | 29151 |

COMPARISON OF AAAC VS ACSR

| Conductor | Wind | $61 / 3.19 \mathrm{AAC}$ |  | $54+7 / 3.18 \mathrm{ACSR}$ |  |
| :---: | :---: | :---: | :---: | :---: | :---: |
|  |  | Tension | Sag | Tension | Sag |
| ${ }^{\circ} \mathrm{C}$ |  |  |  |  |  |
| 32 | $\mathrm{Kgf} / \mathrm{sq} . \mathrm{m}$ | Kgf | m | Kgf | m |
| 53 | 0 | 3288 | 6.26 | 3322 | 7.47 |
| 75 | 0 | 2819 | 7.31 | 2972 | 8.35 |
| 90 | 0 | 2455 | 8.39 | 2686 | 9.24 |
| 0 | 30 | 2262 | 9.11 | N.A. | N.A. |
| 32 | 45 | 3990 | 5.46 | 4362 | 5.69 |

## CONCLUSIONS

For all operating conditions, Sags and Tensions for AAAC are less than for equivalent ACSR. Al so AAAC could be operated with higher Ampacity upto $90^{\circ} \mathrm{C}$ without affecting ground clearance as obtained for ACSR for $75^{\circ} \mathrm{C}$ conductortemperature.

## AAAC VERSUS ACSR ELECTRICAL COMPARISON

All Aluminium Alloy Conductor (6201)

| CODE NAME | AREA KCMil | REACTANCE |  | RESISTANCE |  |
| :---: | :---: | :---: | :---: | :---: | :---: |
|  |  | Capacitive | Inductive | AC $50{ }^{\circ} \mathrm{C}$ | DC $20{ }^{\circ} \mathrm{C}$ |
| Butte | 312.8 | 0.1074 | 0.473 | 0.376 | 0.0644 |
| Canlon | 394.5 | 0.1040 | 0.459 | 0.298 | 0.0311 |
| Cairo | 465.4 | 0.1015 | 0.449 | 0.253 | 0.0133 |
| Darlen | 559.5 | 0.0987 | 0.438 | 0.214 | 0.0300 |
| Elgin | 662.4 | 0.0068 | 0.429 | 0.182 | 0.0309 |
| Flint | 740.8 | 0.0945 | 0.419 | 0.160 | 0.0272 |
| Creele | 927.2 | 0.0913 | 0.406 | 0.129 | 0.0217 |

Aluminium Conductor Steel Reinforced

| RESISTANCE |  | REACTANCE |  | AREA KCmil | CODE |
| :---: | :---: | :---: | :---: | :---: | :---: |
| DC <br> $20^{\circ} \mathrm{C}$ | AC | Inductive | Capacitive |  |  |
| 0.0640 | 0.3792 | 0.485 | 0.1074 | 268.8 | Partridge |
| 0.0507 | 0.3006 | 0.451 | 0.1040 | 338.4 | Linnet |
| 0.0430 | 0.2551 | 0.441 | 0.1015 | 397.5 | Ibis |
| 0.0357 | 0.2120 | 0.430 | 0.0988 | 477 | Hawk |
| 0.0307 | 0.1826 | 0.420 | 0.0965 | 558 | Dove |
| 0.0268 | 0.1598 | 0.412 | 0.0946 | 636 | Grosbeak |
| 0.0215 | 0.1284 | 0.399 | 0.0912 | 795 | Drake |

COMPARISON OF PHYSICAL \& ELECTRICAL PROPERTIES OF 795 KCmil CONDUCTORS $26 / 7$ ACSR DRAKE, AAC, AAAC AND ACAR $1.100^{\prime \prime}$ DIAMETER (EXCEPT ARBUTUS)

| TYPE | ACSR | AAC | AAAC | ACAR |  |  |
| :---: | :---: | :---: | :---: | :---: | :---: | :---: |
| Code Word (if Any) | Drake | Arbutus | Greeley | - | - | - |
| Construction | 26/7 | 37W | 37 W | 18/19 | 24/13 | 30/7 |
| Standing, No. \& Diameter |  |  |  |  |  |  |
| 1350-H19 | $26 \times .1749^{\prime \prime}$ | $37 \times .1466^{\prime \prime}$ | $\cdot$ | $18 \times .1583^{\prime \prime}$ | $24 \times .1583^{\prime \prime}$ | $30 \times .1583^{n}$ |
| 6201-T81 | $\checkmark$ | - | $37 \times .1583^{\prime \prime}$ | $19 \times .1583^{\prime \prime}$ | $13 \times .1583^{\prime \prime}$ | $7 \times .1583^{\prime \prime}$ |
| Steel | $7 \times .1360$ | - | - | . | - | - |
| Actual Area KCMil |  |  |  |  |  |  |
| 1350-H19 | 795,000 | 795,000 | $\cdot$ | 451.100 | 601,400 | 751,800 |
| 6201-T81 | - | - | 927.200 | 476,100 | 325,800 | 175,400 |
| TOTAL | 795,000 | 795,000 | 927,200 | 927,200 | 927,200 | 927,200 |
| DC Resistance $20^{\circ} \mathrm{C}(\Omega / \mathrm{Mt}$.) | . 1135 | . 1152 | . 1147 | . 1061 | 1038 | . 1012 |
| AC Resistance $50^{\circ} \mathrm{C}(\Omega / \mathrm{Mt}$.) | . 1284 | . 1310 | . 1290 | . 1201 | . 1176 | . 1153 |
| Equiv. $61 \% 1350$ Area KCMil | 795,000 | 795,000 | 798,000 | 860,000 | 881,000 | 902,000 |
| Weight, Lbs./1,000 Ft |  |  |  |  |  |  |
| 1350-H19 | 750 | 748.3 | - | 423.5 | 584.5 | 705.8 |
| 6201-T81 | - | - | 870.4 | 446.9 | 305.9 | 164.6 |
| Steel | 344 | - | . | - | - | - |
| TOTAL | 1,094 | 746.3 | 870.4 | 870.4 | 870.4 | 870.6 |
| Rated Strength-Lbs. | 31,500 | 13,900 | 30,500 | 23,400 | 20,900 | 19,000 |
| Strength/Weight Ratio | 28,900 | 18,625 | 35.000 | 26,880 | 24,010 | 21,830 |

COMPARISON OF SAG TENSION DATA FOR 795 KCMIL CONDUCTORS 26/7 ACSR DARKE, AAC, AAAC, AND ACAR, 900-FOOT RULING SPAN-NESC HEAVY LOADING

| CONDUCTOR TYPE | ACSR | AAC | AAAC | ACAR |  |  |
| :--- | ---: | ---: | ---: | ---: | ---: | ---: |
| Code Word (if any) | Drake | Arbutue | Greeley | - | - | - |
| Construction | $26 / 7$ | $37 / \mathrm{W}$ | $37 / \mathrm{W}$ | $18 / 19$ | $24 / 13$ | $30 / 7$ |
| Size (KCMil) | 795 | 795 | 927.2 | 927.2 | 927.2 | 927.2 |
| Overall Diameter in inch | $1.108^{\prime \prime}$ | $1.026^{\circ}$ | $1.108^{\circ}$ | $1.108^{\prime \prime}$ | $1.108^{\circ}$ | $1.108^{\prime \prime}$ |
| Resultant Heavy Loading | 2.519 | 2.135 | 2.308 | 2.298 | 2.298 | 2.298 |
| Rated Tensile Strength | 31,500 | 13,900 | 30,500 | 23,400 | 20,900 | 19,000 |
| Init. Max. Loaded Tension | 11.572 | 7,983 | 11,354 | 11,200 | 10,500 | 10,080 |
| \% RTS | 36.7 | 57.4 | 37.2 | 47.9 | 50.5 | 52.9 |
| Final Sag at 60 |  |  |  |  |  |  |
| Final Sag at $120^{\circ} \mathrm{F}$ | 21.45 | 27.06 | 19.45 | 20.0 | 21.7 | 23.3 |
| Final Sag at 212${ }^{\circ} \mathrm{F}$ | 24.99 | 30.77 | 23.92 | 24.4 | 25.6 | 27.4 |
| Weight per 1.000 Ft. | 29.29 | 35.87 | 29.93 | 30.4 | 31.7 | 32.9 |

ECONOMIC COMPARISON OF 795 KCMIL CONDUCTOR ACSR DRAKE,
AAC, AAAC, AND ACAR $1.108^{\prime \prime}$ DIAMETER (EXCEPT ARBUTUS)

| FACTOR OR METHOD OF CALCULATION |  | DRAKE 795 KCMil 26/7 ACSR | ARBUTUS 795 KCMil 37W AAC | $\begin{gathered} \hline \text { GREELEY } \\ 1.108^{\prime \prime} \\ \text { AAAC } \\ \hline \end{gathered}$ | ACAR <br> 1.108" <br> 18/19 | ACAR 1.108" 24/13 | ACAR 1.108" 30/7 |
| :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: |
| 1. AC Resistance@ $00^{\circ} \mathrm{C} \Omega / \mathrm{Mile}$ | R | 0.1284 | 0.1310 | 0.1290 | 0.1201 | 0.1176 | 0.1153 |
| 2. Conductor Weight - (Lbs./Mile) | W | 5776 | 3940 | 4596 | 4595 | 4596 | 4596 |
| 3. Power Loss $1^{2} \mathrm{R}=300^{2} \mathrm{R}$ KW/Mile | PL | 11.56 | 11.79 | 11.61 | 10.81 | 10.58 | 10.38 |
| 4. Annual Demand Charge Cost $=\mathrm{PL} \times \$ 500 \times .17$ (\$/Mile) | Cd | \$982.60 | \$1,002.15 | \$986.85 | \$918.85 | \$899.30 | \$882.30 |
| 5. Annual Energy Loss: PL $\times 2650$ ( $\mathrm{kW} . \mathrm{h} / \mathrm{Mile}$ ) | Pel | 30,634 | 31,243 | 30,766 | 28,645 | 28,037 | 27,507 |
| 6. Annual Energy Loss Cost: $=$ Pel $\times 0.10$ (\$/Mile) | Cel | \$306.34 | \$312.43 | \$307.66 | \$286.46 | \$280.37 | \$275.07 |
| 7. Total Annual Loss Costs $\mathrm{Cd}+\mathrm{Cel}$ (\$/Mile) | C | \$1,288.94 | \$1,314.58 | \$1,294.51. | $\$ 1,205.3$ | $\$ 1,179.6$ | $\$ 1,157.3$ |
| 8. Annual Savings/ cond. Mile \$/Mile Over ACSR | S | - | -\$25.64 | \$5.57 | \$83.63 | \$109.27 | \$131.57 |
| 9. Press Value of Savings/ COD. Mile Over ACSR $P V=S \frac{1-(1+.08)^{10}}{.08}$ | PV | - | -\$228.71 | -\$62.72 | \$941.67 | $\begin{array}{r} \$ 1,230.3 \\ 8 \end{array}$ | $\begin{array}{\|r} \$ 1,481,4 \\ 8 \end{array}$ |
| 10. Additional Value / Pound of Conductor \$/Lb. | $\frac{P V}{W}$ | - | -\$.07 | -\$0.14 | \$. 205 | \$.268 | \$.322 |

ECONOMIC COMPARISON OF 954 KCMIL ACSR RAIL, AAC, AND ACAR $1.165^{\prime \prime}$ DIAMETER (EXCEPT MAGNOLIA)

| FACTOR OR METHOD OF CALCULATION |  | $\begin{array}{\|c\|} \hline \text { RAIL } 954 \\ \text { KCmil 45/7 } \\ \text { ACSR } \end{array}$ | MAGNOLIA 954 KCmil 37 W AAC | $\begin{array}{\|c\|} \hline \text { ACAR } 1.155^{\prime \prime} \\ 24 / 13 \end{array}$ | $\begin{array}{\|c\|} \hline \text { ACAR } \\ 1.165^{\prime \prime} 30 / 7 \end{array}$ |
| :---: | :---: | :---: | :---: | :---: | :---: |
| 1. Ac Resistance@ $50^{\circ} \mathrm{C}-\Omega / \mathrm{Mile}$ | R | 0.1092 | 0.1100 | 0.1069 | 0.1048 |
| 2. Conductor Weight - Pounds / Mile | W | 5676 | 4731 | 5077 | 5077 |
| 3. Power Loss $1^{2} R=320^{2} \mathrm{R}-\mathrm{kW} / \mathrm{Mile}$ | PL | 11.18 | 11.26 | 10.95 | 10.73 |
| 4. Annual Demand Charge Cost: $\mathrm{Cd}=\mathrm{PL} \times \$ 500 \times 0.17$ \$/Mile | Cd | \$950.30 | \$957.10 | \$930.75 | \$912.09 |
| 5. Annual Energy Loss: Pal - PL $\times 2650-\mathrm{kW}$. h/Mile | Pel | 29,627 | 29,839 | 29,017 | 28,434 |
| 6. Annual Energy Loss Cost: $\mathrm{Cel}=$ Pel $\times .010-\$ \mathrm{Mile}$ | Cel | \$296.27 | \$298.39 | \$290.10 | \$284.34 |
| 7. Total Annual Loss Costs: $\mathrm{Cd}+\mathrm{Cel}-\$ /$ Mile | c | \$1,246.57 | \$1,255.49 | \$1,220.92 | \$1,196.43 |
| 8. Annual Savings/cond. Mile, Over ACSR - \$Mile | S |  | \$-8.92 | \$25.65 | \$50.14 |
| 9. Present Value of Savings/cond. Mile Over ACSR $\operatorname{PV} \frac{1-(1+.08)^{10}}{\operatorname{CB}}=(11.26)$ | PV |  | \$-100.44 | \$288.82 | \$564.58 |
| 10. Additional Value/Pound Conductor \$/Pound | $\frac{P V}{W}$ |  | \$.021 | \$0.057 | \$0.111 |

COMPARISON OF PHYSICAL \& ELECTRICAL PROPERTIES OF 954 KCMIL CONDUCTORS 45/7 ACSR RAIL, AAC, AND ACAR $1.165^{\prime \prime}$ DIAMETER (EXCEPT MAGNOLIA)

| CONDUCTOR TYPE | ACSR | AAC | ACAR |  |
| :---: | :---: | :---: | :---: | :---: |
| Code Word (if Any) | Rail | Magnolia |  |  |
| Construction | 45/7 | 37W | 24/13 | 30/7 |
| Stranding, No. \& Diameter. |  |  |  |  |
| 1350-H19 | $45 \times 1456^{1}$ | - | $24 \times .1664^{\prime \prime}$ | $30 \times 1664$ |
| 6201-T81 | - | $37 \times .1606^{\prime \prime}$ | $13 \times .1664^{\prime \prime}$ | 7×.1664" |
| Steel | 7x.0971 ${ }^{\text {² }}$ | - | . | - |
| Actual Area - omil |  |  |  |  |
| 1350-H19 | 954,000 | 954,000 | 664,500 | 830,670 |
| 6201-T81 | - | - | 360,000 | 193,830 |
| TOTAL | 954,000 | 954,000 | 1,024,500 | 1,024,500 |
| DC Resistance $20^{\circ} \mathrm{C}(\Omega / \mathrm{ml})$ | .0958 | . 0960 | . 0937 | . 0915 |
| AC Resistance $50^{\circ} \mathrm{C}(\Omega / \mathrm{ml})$ | .1092 | . 110 | . 1069 | . 1048 |
| Equiv. 61\% 1350 Area Cmil | 954,000 | 954,000 | 974.000 | 997,500 |
| Weight Lbs./1,000 Ft. |  |  |  |  |
| 1350.H19 | 900 | 896.0 | 623.8 | 779.8 |
| 6201-T81 | - | - | 337.8 | 181.8 |
| Steel | 175 | - | - | - |
| TOTAL | 1,075 | 896.0 | 961.6 | 961.6 |
| Rated Strength Lbs, | 25,900 | 16,400 | 22,600 | 20,400 |
| Strength/Weight Ratio | 24,100 | 18,300 | 23,500 | 21,200 |

COMPARISON OF SAG TENSION DATA FOR 954 KCMIL CONDUCTORS 45/7 ACSR RAIL AAC, AND ACAR, 1,000-FOOT RULING SPAN - NESC - HEAVY LOADING

| CONDUCTOR TYPE | ACSR | AAC | ACAR |  |
| :--- | ---: | ---: | ---: | ---: |
| Code Word (if Any) | Rail | Magnolia |  |  |
| Construction | $45 / 7$ | 37 W | $24 / 13$ | $30 / 7$ |
| Size | 954 kcmil | 954 kcmil | $1,024.5 \mathrm{kcmil}$ | $1,024.5 \mathrm{kcmil}$ |
| Overall Diameter | 1,165 | $1,124^{\prime \prime}$ | 1,165 | 1,165 |
| Resultant Heavy Loading | 2,541 | 2,343 | 2,424 | 2,424 |
| Rated Tensile Strength | 25,900 | 16,400 | 23,100 | 20,400 |
| Init. Max. Loaded Tension | 10,000 | 7,885 | 10,107 | 9,277 |
| $\%$ RTS | 38.6 | 48.1 | 43.3 | 45.5 |
| Final Sag at $60^{\circ} \mathrm{F}$ | 34.20 | 38.69 | 30.6 | 33.2 |
| Final Sag at $120^{\circ} \mathrm{F}$ | 37.92 | 42.11 | 34.7 | 37.1 |
| Final Sag at $212^{\circ} \mathrm{F}$ | 43.12 | 47.0 | 40.3 | 42.4 |
| Weight per $1,000 \mathrm{Ft}$ | 1,075 | 895.5 | 962 | 962 |

TECHNICAL DATA \& INFORMATION ABOUT CONDUCTORS

## Applicable Indian / International Standards References

## a. Indian Standards

1. IS 9997/1991
2. IS 504/1963
3. IS 2658/1964
4. IS 3635/1986
5. IS 398(P.|V) / 1979
6. IS 398(P-IV) / 1994
7. REC specification 33/ 1991(R)
8. IS 398 (P-I) / 1976
9. IS 398 (P-II) / 1976
10. IS 398 (P-V) / 1982
11. IS 209-1992
12. IS 2633-1990
13. IS 1521-1991
14. IS 2629-1990
15. IS 4826-1992
16. IS 6745-1991
17. IS 8263-1976
18. IEC 1089-1991
19. IS 1778/1980
20. IS 1841-1978
21. IS 3975
22. IS 7623-1985
23. IS 5484-1978
24. IEC-207-889-1089
25. IS 14255-1995
b. International Standards
26. BS-215 (P-1, P-2) 1970
27. BS 4565-1990
28. BS 443-1990
29. BS 183-1982
30. BS 3288
31. ASTM Standard
32. French standard sizes
33. Canadian Standards
34. DIN 48204
35. DIN 48021
36. DIN VDE $0210,0211,46391,48303,57103$
37. BS 3242-1970

With latest version for Aluminium Alloy Ingots
With latest version for Chemical Analyser
With latest version for Tensile test
With latest version
for AAAC Conductor
With latest version for AAAC conductor
for AAAC conductor
With latest version
and IS 398 (P-II)/1996
for Extra High Voltage configuration

With latest version

For lithium base grease Grade-II

For Arial Bunch Cable
for ACSR / AAC Conductor
for Galvanized Steel wire
for Testing of Zinc Coating
For general purpose Galvanised steel wire.

AAAC conductors
for all Aluminium Alloy Conductors
for ALUMINIUM Alloy Conductor

## IMPORTANT - TERMINOLOGY - PARAMETERS

MODULES OF ELECTRICITY $=\frac{9.9 \mathrm{~m}+28}{\mathrm{~m}+1} \times 10^{6} \mathrm{lb} / \mathrm{IN}^{2}$ (Where $\mathrm{m}=$ ratio of Aluminium section to steel section)
$\alpha$ (Coefficient of linear expansion) $=\frac{12.78 \mathrm{~m}+18.1}{\mathrm{~m}+2.83} \times 10^{6}$ per degree F
Weight per ft. per $\mathrm{IN}^{2} \quad=\frac{1.21 \mathrm{~m}+3.31}{\mathrm{~m}+1} \mathrm{lb}$
$d=\frac{W I^{2}}{2 T} \quad$ Where $d=$ Sag; $I=$ half span: $T=$ permissible line Tension
$W=\sqrt{\left(w+w_{1}\right)^{2}+w_{w}^{2}} \quad \begin{array}{ll}W=\text { Total force on conductor; } w=\text { Weight of Conductor } / f t ; w_{w}=\text { Wind pressure } \\ W_{1}=\text { Weight of Ice }\left(=p(0.5 D+R)^{2} \cdot(0.5 D)^{2} \times \frac{1}{144} \times \text { Weight of } 1 \mathrm{cu} . \mathrm{ft} \text { of Ice }\right)\end{array}$
Where $\quad R=$ Radial thickness of Ice; $\quad \mathrm{F}=$ Stress ( T/a: Tension per unit area);
$\mathrm{D}=$ Diameter of conductor $\mathrm{T}=$ Working Tension of conductor
$\mathrm{a}=$ area of cross section of conductor
Reactance calculation :
$\begin{array}{ll}\text { Single phase }: L=0.741 \log _{10} \frac{D}{r} \mathrm{mH} / \text { mile } & r=\text { radius } \\ D=\text { Spacing between conductor }\end{array}$
Three phase : $\mathrm{L}=0.08+0.741 \log _{10} \underline{\mathrm{D}} \mathrm{mH} /$ mile $\quad \mathrm{L}=$ Inductance
$X=$ Reactance
$\mathrm{f}=\mathrm{frequency}$
$X=2 \pi \mathrm{f} \times 10^{3}$ ohms
$\mathrm{mH}=$ mili henries

## LAY RATIO

Ratio of the Axial Length of complete turn of helix formed by an individual wire in a standard conductor to the external diameter of helix.
The axial length of spiral of wire in layer is called a lay and is often expressed as a multiple of mean diameter of the layer containing the wire is called the lay ratio.

- If the lay ratio is 'r', the length of the wire is $\sqrt{1+(\pi / r)^{2}}$ times the axial length.
- Lay ratio factor is often taken as 1.0217
- Stranding causes $2 \%$ increase in the resistance.
- Generally resistance of Aluminium wire only is considered, as steel wire offers very high resistance.
- The strength of Aluminium wire ranges from $23000 \mathrm{lb} . / \mathrm{In}^{2}$ (Large wire); $28000 \mathrm{lb} . / \mathrm{In}^{2}$ (Small wire) and of Steel wire 179000 to $200,000 \mathrm{lb} . / \mathrm{ln}^{2}$


## LINE CONDUCTORS AND SUPPORTING STRUCTURES

## Properties of Stranded Conductors

All conductors employed on overhead lines are preferably stranded, on account of the increased flexibility thereby obtained. Solid wires, except in the smaller sizes, are different to handle, and when used for long spans tend to crystallise at the points of support due to swinging in the wind.
In stranded conductors there is generally one central wire, and round this, successive layers of wires containing 6,12,18,24... wires. Thus if there are $\boldsymbol{n}$ layers, the total number of individual wires employed is

$$
N=3 n(n+1)+1 \ldots \ldots \ldots . .97
$$

In the process of manufacture, the consecutive layer of wires are twisted or spiralled in opposite directions, the effect being to bind all the layers together. This method of construction is known as concentric lay.
With very large sections of conductor, however, another method of stranding called 'rope lay is sometimes used as it gives a more flexible conductor.
When a current enters a stranded conductor it divides among the wires, and each separate current, for all practical purposes, remains in its own wire throughout the length of the conductor. This is because the individual wires being circular touch only along lines, and the surface resistance, due to dirt and the formation of oxide or sulphide, has a fairly high value. The result is that each current, in general, pursues a spiral path of greater length than the length of the conductor as a whole, and this offective increase of the path length correspondingly increases the resistance. The precise magnitude of this effect depends on the lay adopted for the conductor, meaning by this term the axial length of one complete turn of any wire. The lay is usually expressed numerically in terms of the mean diameter of the layer containing the wire.
There is no fixed lay used by all manufacturers, but in wire tables the assumption is usually made that the length, and corresponding resistance, of all wires except the straight central one, is increased by $2 \%$ above the values for the central one. This is equivalent to assuming that every twisted wire has a lay ratio of about 15.6.
Another effect of stranding is to modify slightly the fundamental formula for inductance, which is based on a solid round conductor. According to Dwight', the inductance per mile of concentric-lay conductor is as follows:-

3-Strand conductor, $L_{0}=\left(0.125+0.741 \log _{10} \frac{d}{r}\right) 10^{3}$ henries,
7 Strand conductor, $L_{0}=\left(0.103+0.741 \log _{10} \frac{d}{r}\right) 10^{3}$ henries,
19-Strand conductor, $L_{2}=\left(0.089+0.741 \log _{10} \frac{d}{r}\right) 10^{3}$ henries,
37-Strand conductor, $L_{0}=\left(0.085+0.741 \log _{10} \frac{d}{r}\right) 10^{3}$ henries,
61-Strand conductor, $L_{0}=\left(0.083+0.741 \log _{10} \frac{d}{r}\right) 10^{3}$ henries,

Where $\boldsymbol{d}$ is the interaxial distance between conductors, and $\boldsymbol{r}$ is the overall radius of the conductor, both measured in the same units. For conductors having more than sixty-one strands, the formula for solid conductors.
$\mathrm{L}_{0}=\left(0.080+0.741 \log _{10} \frac{\mathrm{~d}}{\mathrm{r}}\right) 10^{3}$ henries/mile, is used.

## Voltage Limitations of Line

The critical voltage limit of a line can be raised by increasing either the spacing or the size of the conductors, but the latter method is preferable as the spacing must be kept down to a minimum value in order to save tower costs, and avoid excessive reactance drop in the line. For increasing the size of the conductors, stranded conductors with hemp centers have occasionally been employed, but have not proved satisfactory from a mechanical point of view owing to the hemp deteriorating rapidly.

Steel-cored aluminium conductors have a much greater diameter than copper ones of the same conductivity, and this consideration often leads to the choice of steel-cored aluminium for systems operating near the corona limit.
In a special conductor construction introduced by the Anaconda Wire and Cable Co., one or more layer of copper strands are spiralled round a core of twisted copper, I-beam in shape. Thus strength is added to the holl ow conductor without the addition of dead weight or sacrifice of conductivity or durability. Another design coming into use consists of a number of tongued and grooved rectangular copper sections, which are spiraled along the length of the conductor to form a hollow tube.
In general, it is not advisable to operate a line above its fair weather disruptive critical voltage $\mathrm{E}_{0}$ (determined for $25^{\circ} \mathrm{C}$ and average barometric conditions). If the operating voltage happens to be just below this value the corona losses in fine weather will be negligible. They may, however, have a fairly high value under storm conditions, but, since storms are only experienced at intervals in most districts, it is usually more economical to pay for these losses for small parts of the year than try to eliminate them absolutely by using heavy conductors.

## Thermal Current Rating

The steady state thermal rating of a conductor is calculated from the following heat balance equation according to IEEE method
$I^{\prime} r A c+q=q,+q_{c}$
$I=\sqrt{\frac{q_{t}+q_{c}-q_{s}}{r A C}}$

Where,
$I=$ steady state current, amps
$r_{\text {w. }}=\mathrm{AC}$ resistance of conductor, ohms
$q_{\mathrm{x}}=$ heat gain from the sun
$\boldsymbol{q}_{\mathrm{r}}=$ radiation heat loss
$q_{c}=$ convection heat loss

## AC Resistance of Conductor

$$
r_{d c}=K r_{d c}
$$

Where,
$r_{d z}=D C$ resistance at the operating temperature ohms/meter.
$K=$ skin effect factor

The DC resistance at the operating temperature is calculated by taking the value of temperature coefficient of resistance as $0.004 /{ }^{\circ} \mathrm{C}$.

## Heat gain from sun

```
q}=\textrm{a}\mp@subsup{Q}{8}{}(\operatorname{sin}0)\quad\mp@subsup{\textrm{A}}{}{\prime}\textrm{W}/\mathrm{ meter
Where
a=coefficient of solarabsorption
    (=0.23 to 0.91)
Q}=\mathrm{ solar and sky radiated heat,
W/m
A'= Projected area of conductor, }\mp@subsup{m}{}{2}\mathrm{ per lineal meter
Q= 和 (
Where,
\(H c=\) altitude of sun, degrees
\(Z c=\) azimuth of sun, degrees
\(Z 1=\) azimuth of conductor, degrees
```


## Radiation Heat Loss

$$
q=0.178 d e\left[\left(\frac{t c+273}{100}\right)^{4}-\left(\frac{t a+273}{100}\right)^{4}\right] W / m
$$

> Where $d=$ conductor diameter.cm $e=$ coefficient of emissivity $$
(=0.23 \text { to } 0.91)
$$

$t_{c}=$ conductor temperature, ${ }^{\circ} \mathrm{C}$
$t_{e}=$ ambient temperature, ${ }^{\circ} \mathrm{C}$

## Natural Convection (still Wind) Heat Loss

At sea level

$$
q_{\mathrm{cv}}=0.1174 d^{733}(\mathrm{tc}-\mathrm{ta})^{-1.2} \mathrm{~W} / \mathrm{m}
$$

At altitudes above sea,

$$
q_{\mathrm{cv}}=0.1152 p f^{6 . s}(t c-t a) \mathrm{W} / \mathrm{m}
$$

Where
$P f=$ air density, $\mathrm{kg} / \mathrm{m}^{3}$ attemperature of airfilm, $\overline{t f=(t c+t a)}$

2

## Forced Convection (with wind) Heat loss

$$
q_{c}=\left[1.01+4.474\left(\frac{d p f V}{f}\right)^{0.52}\right] K f(t c-t a) W / m .
$$

## Where

$V=$ wind velocity normal to conductor, $\mathrm{km} /$ hour, taken as 2.2.
$f=$ absolute viscosity of air, kg/h. mat tf.
$K f=$ thermal conductivity of air at tf .

| SI.No. | ACSR Conductor <br> Bundle | $75^{\circ} \mathrm{C}$ Still Wind |  |  |  |
| :---: | :--- | :---: | :---: | :---: | :---: |
|  |  | Phase <br> current <br> Amps | Power <br> Limit MVA | Phase <br> Current <br> Amps | Power <br> Limit MVA |
|  |  | 504 | 698 | 1240 | 1718 |
| 2 |  | 574 | 795 | 1432 | 1984 |
| 3 | Zebra' Quad | 918 | 1272 | 2220 | 3076 |
| 4 | Moose' Quad | 1008 | 1397 | 2480 | 3436 |
| 5 | Bersmis' Quad | 1148 | 1590 | 2864 | 3968 |

Conductor Bundle Parameters of 400 kV Double Circuit Transmission Lines

| SI No. | Particulars | Twin <br> Moose | Twin <br> Bersmis | Quad <br> Zebra | Quad <br> Moose | Quad <br> Bersmis |
| :---: | :--- | :---: | :---: | :---: | :---: | :---: |
| 1 | 2 | 3 | 4 | 5 | 6 | 7 |
| 1 | Thermal rating in MVA |  |  |  |  |  |
|  | (I) No wind | 698 | 795 | 1272 | 1397 | 1590 |
|  | (II) 2.2 kmph wind | 1718 | 1984 | 3076 | 3436 | 3968 |
| 2 | Surge Impedance |  |  |  |  |  |
|  | Loading in MW | 1146 | 1158 | 1404 | 1419 | 1429 |
| 3 | Interference Performance |  |  |  |  |  |
|  | (I) Max. conductor surface voltage gradient, kV/cm | 17.7 |  | 13.09 | 10.21 |  |
|  | (II) Corona extinction voltage, kV | 310 | 338 | 399 | 435 | 472 |
|  | (III) Radio interference level, dB | 61.1 | - | 35.9 | - |  |
| 4 | Capital cost per km (Rs) | 15.96 | 18.51 | 23.9 | 27.74 | 30.24 |
| 5 | Annual operating cost/km/MW of SIL (Rs) | 413 | 380 | 410 | 432 | 461 |
| 6 | Annual operating cost/km/MW (Rs) at |  |  |  |  |  |
|  | (I) 1000 MVA power flow | 428 | 430 | 490 | 541 | 602 |
|  | (II) 1400 MVA power flow | 405 | 382 | 410 | 436 | 467 |

## CONDUCTOR TEMPERATURE RISE AND CURRENT CARRYING CAPACITY.

In distribution and transmission line design the temperature rise of conductor above ambient while carrying current is important. While power loss, voltage regulation, stability and other factors may determine the choice of conductor for a given line, it is sometimes necessary to consider the maximum continuous current carrying capacity of a conductor. The maximum continuous current rating is necessary because it is determined by the maximum operating temperature of the conductor. This temperature affects the sag between towers or poles and determines the loss of conductor tensile strength due to annealing. For short tie lines or lines that must carry excessive loads under emergency conditions, the maximum continuous current-carrying capacity may be important in selecting the proper conductor.
The following discussion presents the Scouring and Frick ${ }^{6}$ formulas for calculating the approximate current-carrying capacity of conductors under known conditions of ambient temperature, wind velocity, and limiting temperature rise.
The basis of this method is that the heat developed in the conductor by $l^{2} R$ loss is dissipated (1) by convection in the surrounding air . and (2) radiation to surrounding objects. This can be expressed as follows:
$I^{\prime} R=\left(W_{c}+W_{r}\right) A$ watts

> Where
> $I=$ Conductor current in amperes.
> $R=$ Conductor resistance per foot.
> $W c=$ Watts per square inch dissipated by convection
> $W r=$ Watts per square inch dissipated by radiation
> $A=$ Conductor surface area in square inches per foot of length.

The watts per square inch dissipated by convection, Wc can be determined from the following equation :
$W_{c}=\frac{0.0128 \sqrt{p v}}{T_{a}{ }^{0.123} \sqrt{d}} \Delta t$ Watts per square inch
$P=$ pressure in atmospheres ( $\mathrm{p}=1.0$ for atmospheric pressure).
$V=$ velocity in feet per second.
$T_{a}=$ (degree Kelvin) average of absolute temperatures at conductor and air.
$d=$ outside diameter of conductor in inches.
$\Delta t=($ degree $C)$ temperature rise.

This formula is an approximation applicable to conductor diameters ranging from 0.3 inch to 5 inches or more when the velocity of air is higher than free convection air currents ( $0.2-0.5 \mathrm{ft} / \mathrm{sec}$.)
The watts per square inch dissipated by radiation W, can be determined from the following equation:

(Watts per square inch)
Where
$E=$ relative emissivity of conductor surface
( $E=1.0$ for "black body", or 0.5 for average oxidized copper).
$T=$ (degrees Kelvin ) absolute temperature of conductor.
$T_{a}=$ (degrees Kelvin ) absolute temperature of surroundings.

By calculating ( $W c+W r$ ) $A$, and $R$, it is then possible to determine I from $E q$ (75). The value of $R$ to use is the a-c resistance at the conductor temperature (ambient temperature plus temperature rise) taking into account skin effect as discussed previously in the section on positive and negative-sequence resistances.

This method is, in general, applicable to both copper and aluminium conductors. Tests have shown that aluminium conductors dissipate heat at about the same rate as copper conductors of the same outside diameter when the temperature rise is the same. Where test data is available on conductors, it should be used. The above general method can be used when test data is not available, or to check test results.
The effect of the sun upon conductor temperature rise is generally neglected, being some $3^{\circ}$ to $8^{\circ} \mathrm{C}$. This small effect is less important under conditions of high temperature rise above ambient.
The tables of Electrical Characteristics of Conductors include tabulations of the approximate maximum current carrying capacity based on $50^{\circ} \mathrm{C}$ rise above an ambient of $25^{\circ} \mathrm{C}, ~\left(75^{\circ} \mathrm{C}\right.$ total conductor temperature), tarnished surface ( $\mathrm{E}=0.5$ ), and an air velocity of 2 feet per second. These conditions were used after discussion and agreement with the conductor manufacturers. These thermal limitations are based on continuous loading of the conductors.

The technical literature shows little variation from this condition as line design limits. The ambient air temperature is generally assumed to be $25^{\circ} \mathrm{C}$ to $40^{\circ} \mathrm{C}$ whereas the temperature rise is assumed to be $10^{\circ} \mathrm{C}$ to $60^{\circ} \mathrm{C}$. This gives a conductor total temperature range of $35^{\circ} \mathrm{C}$ to $100^{\circ} \mathrm{C}$. For design purpose copper or ACSR conductor total temperature is usually assumed to be $75^{\circ} \mathrm{C}$ as use of this value has given good conductor performance from an annealing standpoint, the limit being about $100^{\circ} \mathrm{C}$ where annealing of copper and aluminium begins.

## COMPARISON BETWEEN ALUMINIUM AND COPPER

| Sr. <br> No. | Description | Aluminium | Copper |
| :---: | :--- | :--- | :--- |
| 1 | Coefficient of Linear expansion | $23 \times 10^{6} \mathrm{deg} . \mathrm{C}$ | $16.6 \times 10^{6} \mathrm{deg} . \mathrm{C}$ |
| 2 | Density | $2.703 \mathrm{gm} / \mathrm{cm}^{3}$ | $8.80 \mathrm{gm} / \mathrm{cm}^{3}$ |
| 3 | Weight of I sq. ft. | 169.18 lb. | 554.98 lb. |
| 4 | Modulus of elasticity | $9.9 \times 10^{6}$ | $18 \times 10^{6}$ |
| 5 | Standard resistivity at $20^{\circ} \mathrm{C}$ | 2.8735 micro $\Omega / \mathrm{cm}^{3}$ | $0.694 \mathrm{micro} \Omega / \mathrm{cm}^{3}$ |
| 6 | Temperature Coefficient of <br> Resistivity | 0.00407 per ${ }^{\circ} \mathrm{C}$ | 0.004 per ${ }^{\circ} \mathrm{C}$ |

Total strength of Aluminium plus steel conductor is found to be 50\% of greater than equivalent copper conductor. As such weight of Aluminium conductor is half of copper conductor.
Density of steel is taken as $7.80 \mathrm{gm} / \mathrm{cm}^{3}$

## VIBRATION DAMPER DESIGN

Damping constant for high frequency oscillation is defined by $3.26 \times \mathrm{V} / \mathrm{d}$ cycles $/ \mathrm{Sec}$. Where $V=$ Wind Velocity and; $d=$ diameter of conductor

## CLEARANCES AT RAILWAY CROSSING

## Vertical Clearance

| 1) | upto and including 11 kV | 10.95 Mtr (by cable) |
| :--- | :--- | :--- |
| 2) | above 11 kV upto 66 kV | 14.10 Mtr |
| 3) | above 66 kV upto 132 kV | 14.60 Mtr |
| 4) | above 132 kV upto 220 kV | 15.40 Mtr |
| 5) | above 220 kV upto 400 kV | 17.90 Mtr |

Electrical Clearances (IS 5613)

|  | $\mathbf{6 6} \mathbf{~ k V}$ | $\mathbf{1 3 2} \mathbf{~ k V}$ | $\mathbf{2 2 0} \mathbf{~ k V}$ | $\mathbf{4 0 0} \mathbf{~ k V}$ |
| :--- | :---: | :---: | :---: | :---: |
| Ground clearance- (Mtrs) | 6.1 | 6.1 | 7.015 | 9.0 |
| Building- |  |  |  |  |
| Vertical - (Mtrs) | 3.97 | 4.58 | 5.49 | 8.00 |
| Horizontal - (Mtrs) | 2.14 | 2.75 | 3.66 | 8.00 |
| Between Lines: |  |  | 4.58 |  |
| Line to Line - (Mtrs) | 2.44 | 3.05 |  |  |
| ph-ph |  |  | S/C | D/C |
| Horizontal - (Mtrs) | 3.5 | 6.8 | 6 | 8.4 |
| Vertical - (Mtrs) | 2.0 | 3.9 | 4.9 for both | 8.00 |

1) Working Ground Adjustment to The tower $\cdot 5 \mathrm{Mtr}$
2) Explosive Distance -4.5 Mtr

FOREST WAY LEAVE

| kV | Right of Way (Mtr) Width (Max) | Vertical clearance (Mtrs) (1 tree top to conductor) |  |
| :---: | :---: | :---: | :---: |
| 11 | 7 | 2.6 | Power line |
| 33 | 15 | 2.8 |  |
| 66 | 18 | 3.4 |  |
| 132 | 27 | 4.0 | Crossing Angle |
| 220 | 35 | 4.6 | $90^{\circ} \cdot 60^{\circ}$ |
| 400 | 52 | 5.5 |  |
| 800 | 85 | . |  |

MINIMUM CLEARANCE BTW. EHV TELECOM WIRES

| Line Voltage | $>36 \mathrm{kV} \leq 72.5 \mathrm{kV}$ | $2440 \mathrm{~mm}\left(8^{\prime} \mathrm{O}^{\prime \prime}\right)$ |
| :--- | :--- | :--- |
|  | $>72.5 \mathrm{kV} \leq 145 \mathrm{kV}$ | $2740 \mathrm{~mm}\left(9^{\prime} \mathrm{O}^{\prime \prime}\right)$ |
|  | $>145 \mathrm{kV} \leq 245 \mathrm{kV}$ | $3050 \mathrm{~mm}\left(10^{\prime} 0^{\prime}\right)$ |
|  | $>245$ and above | $3050(+305 \mathrm{~mm}$ for every $33 \mathrm{kV} \&$ part <br> thereof) |

SPAN AND STRUCTURE HEIGHT DETAILS OF EHV LINES - GENERALLY ADOPTED

| Sr. <br> No. | Voltage <br> KV | Type of <br> Structure | Span in <br> Meters | Height of Tower <br> Meters | Ground clearance <br> Meter |
| :---: | :---: | :---: | :---: | :---: | :---: |
| 1. | 66 kV <br> Single Circuit | H-Frame | 200 | 11 | 6.1 |
| 2. | 66 kV <br> Double Circuit | Tower | 260 | 21 | 6.1 |
| 3. | 132 Kv Single/ <br> Double Circuit | Tower | 350 | 30 | 6.1 |
| 4. | 220 kV <br> Single $/$ Double <br> Circuit | Tower | 350 | 34 | 7.1 |
| 5. | 400 kV Single <br> Circuit | Tower | 400 (normal <br> span in open <br> land) | 38 | 9 |
| 6. | 400 kV Double <br> Circuit | Tower | $400-460$ Meter | 51 | 9 |

## DICABS

## CURRENT CARRYING CAPACITY OF BARE OVERHEAD TRANSMISSION LINE CONDUCTORS

1.0 The current carrying capacity (Ampacity) of a bare, overhead transmission line conductor is that current (amps) which may flow in it continuously while maintaining a steady maximum permissible temperature over its surface. The maximum permissible temperature is that which does not permanently and adversely affect the physical properties of the conductor material.

The current carrying capacity of a conductor is based on the concept that under a state of thermal equilibrium, the total heat gained by the conductor due to energy loss (PR) within itself and by solar and sky radiation equals the total heat lost by the conductor by conduction to the metallic supporting it, by convection to the air surrounding it and by radiation to its surrounding objects.
1.1 Factors influencing the steady state.

| 1.1.1 | Conductor Material and its physical properties | Material: | Copper, Aluminium Steel and their Alloys |
| :---: | :---: | :---: | :---: |
|  |  | Construction: | Monometal, Composite |
|  |  | Size: | Overall diameter |
|  |  | Resistance: | $D C$ and $A C$ resistance at supply frequency and conductor temperature |
|  |  | Surface condition: | Ability to absorb and emit heat |
| 1.1.2 | Geographical | Location: | Altitude of line above sea level Absolute viscosity, density and thermal conductivity of air. |
|  |  | Position: | Altitude of Sun. Azimuth of Sun, Azimuth of line. |
| 1.1 .3 | Meteorological | Wind Speed: | Laminar or turbulent flow Season of Year |
|  |  | Ambient temperatu | Time of day |

1.2 Except the conductor materials, construction and its diameter which could, perhaps be known to a fair degree of accuracy, none of the other factors are constant at any given point of time and cannot be assessed accurately. A transmission line does not run at the same altitude nor in same direction throughout its length of several kilometers (often in hundreds) nor the ambient temperature and wind speed could be excepted to be same throughout its length. The speed of wind and its turbulence as also the ambient temperature are constantly changing parameters in any given period of time of day or season of a year. So also is the extent of radiation from Sun and Sky. On these counts, the Ampacity of a conductor is not a constant figure but varies according to the prevailing conditions of weather, season and time of day. Ampacity is therefore calculated for certain assumed steady state conditions on an average basis for on assumed maximum conductor temperature as a guide for safe loading of the conductor without affecting its physical properties.
1.3 Several researchers have formulated theories and formulas, which differ from each other, though the basic concept is the same. Many of these formulae are more of academic interest than of practical applications. The effect of Sky radiation, Altitude, position of Sun, orientation of line etc. affect the Ampacity only marginally and many utilities neglect them for Ampacity calculations. One such method is given below for a ACSR conductor of composite construction and a AAAC conductor of Monometal construction, both being of samewire size \& same overall diameter.
2.0 Symbols

```
I = Conductor current, amps at 50 Hz
D = Conductor outer diameter, meters
d = Conductor inner diameter, meters
A = Projected area of conductor per meter length, Sq.m.
a = Coefficient of Solar absorption of conductor
e = Coefficient of Emissivity of conductor
a = Constant mass temperature coefficient of resistance of conductor per }\mp@subsup{}{}{\circ}\textrm{C
R Rd20 = D.C. resistance of conductor at 20 %}\textrm{C}.,\Omega/\textrm{km
Roduc = D.C. resistance of conductor at temperature t}\mp@subsup{t}{c}{}\mp@subsup{}{}{\circ}\textrm{C}.,\Omega/\textrm{km
R Redse = A.C. resistance of conductor at 50 Hz and temperature t. }\mp@subsup{}{c}{}\mp@subsup{}{}{\circ}\textrm{C},,\Omega/\textrm{km
```

$\mathrm{t}_{6} \quad=\quad$ Average conductor temperature, ${ }^{\circ} \mathrm{C}$
$\mathrm{t}_{3} \quad=$ Average ambient temperature, ${ }^{\circ} \mathrm{C}$
$\mathrm{K} \quad=\quad$ Average conductor temperature, $\mathrm{Kelvin}=\mathrm{t}_{\mathrm{c}}+273$
$\mathrm{K}_{\mathrm{s}} \quad=$ Average ambient temperature, Kelvin $=\mathrm{t}_{\mathrm{a}}+273$
$T_{1}=$ Average air film temperature $=\left(t_{\mathrm{c}}+\mathrm{t}_{2}\right) / 2$
$\mathrm{V}=$ Average velocity of wind, meters / hour
$\mathrm{P}_{1}=$ Density of air at temp. $\mathrm{t}_{\mathrm{i}} \mathrm{kg} / \mathrm{cu} . \mathrm{mtr}$
$\mathrm{m}_{+}=$Absolute viscosity of air at temp. t, Kgf/hr. (m)
$\mathrm{K}=$ Thermal conductivity of air at temp $\mathrm{t}_{1}$ watts $/ \mathrm{m}\left({ }^{\circ} \mathrm{C}\right)$
$\mathrm{s}=$ Stefan-Baltzman constant $=5.678 \times 10^{8}$ watts/ Sq. m. $/ \mathrm{K}^{2}$
q $=$ Effective angle of incidence of sun's rays on conductor surface, degrees
$\mathrm{S}=$ Direct Solar irradiation on conductor surface, watts/Sq. m .
$\mathrm{S}_{1} \quad=$ Sky radiated heat on conductor surface, watts/Sq. m.
$\mathrm{W}_{\mathrm{s}} \quad=$ Heat gained by conductor by solar radiation per linear meter, watts/Mtr:
$\mathrm{W}_{\mathrm{e}} \quad=$ Heat lost by conductor by convection per linear meter, watts $/ \mathrm{m}$.
$\mathrm{W}, \quad=$ Heat lost by conductor by radiation per linear meter, watts $/ \mathrm{m}$.

### 3.0 FORMULAE

### 3.1 Fundamental Heat balance equation

$I^{2}\left(\mathrm{R}_{\mathrm{oc}} / \mathrm{t}_{\mathrm{e}}\right)=\mathrm{W}_{\mathrm{e}}+\mathrm{W}_{\mathrm{t}} \cdot \mathrm{W}_{\mathrm{o}}$
Heat lost by conductor by conduction to connected metallic parts is insignificant and therefore neglected.
3.2 Heat gained by conductor due to Solar irradiation
$W_{s}=a\left(S \operatorname{Sin} \theta+S^{\prime}\right) D$ Watts $/ m$
Heat gained by sky radiation $\left(S^{1}\right)$ is negligible and hence neglected. For worst condition $\operatorname{Sin} \mathrm{q}=1$. Therefore,
$W_{s}=a S D$ watts $/ m$. where
$a=0.23$ to 0.85 for conductor upto 1 year age and 0.90 to 0.95 for conductor above 1 year age
3.3 Heat lost by conductor by radiation

| $W_{t}=$ | $\sigma \varepsilon \pi D\left(\mathrm{~K}^{4} \cdot \mathrm{~K}_{4}^{4}\right)$ watts $/ \mathrm{m}$. |
| ---: | :--- |
| $\varepsilon=$ | $0.17838 \times 10^{-6} \times \varepsilon \times \mathrm{D}\left(\mathrm{K}_{\mathrm{4}}^{4} \cdot \mathrm{~K}_{n}^{4}\right)$ watts $/ \mathrm{m}$. where, |
| $\varepsilon=$ | 0.45 for conductor less than 1 years age |
|  | 0.75 for conductor 1 year to 10 years age |
|  | 0.85 for conductor over 10 years age |

3.4 Heat lost by conductor by convection
3.4.1 Natural Convection loss (wind speed less than $2200 \mathrm{~m} / \mathrm{hr}$ )
$W_{0}=3.71272 D^{075}\left(\mathrm{t}_{\mathrm{c}}-\mathrm{t}_{3}\right)^{125} \mathrm{watts} / \mathrm{m}$. at sea level
$W_{c}=3.6461606\left(p_{c}\right)^{05} D^{0,75}\left(t_{c}-t_{c}\right)^{125}$ watts/m at altitudes above sea level

### 3.4.2 Forced convection loss (wind speed $2200 \mathrm{~m} / \mathrm{hr}$ and above)

$$
\begin{aligned}
& W_{\mathrm{ct}}=\left\{1.00531+1.35088\left(\mathrm{D}_{\mathrm{o} 1} \mathrm{~V} / \mu \mathrm{f}\right)^{0.52}\right\} \mathrm{k}_{\mathrm{f}}\left(\mathrm{t}_{\mathrm{c}}-\mathrm{t}_{\mathrm{p}}\right) \text { watts } / \mathrm{m} \\
& \mathrm{~W}_{\mathrm{c} 2}=\left\{0.75398\left(\mathrm{D}_{\mathrm{p} \mathrm{t}} \mathrm{~V} / \mu \mathrm{f}\right)^{0.6}\right\} \mathrm{k}_{\mathrm{f}}\left(\mathrm{t}_{\mathrm{c}}-\mathrm{t}_{\mathrm{s}}\right) \text { watts } / \mathrm{m}
\end{aligned}
$$

Whichever is higher of the above two equations is to be considered. The values of $\mathrm{pf}, \mu \mathrm{f}$ and kf at air film temperature, tf are taken from Table-1.

### 3.5 A.C. resistance of conductor

$$
\begin{aligned}
& \text { 3.5.1 Composite ( } \mathrm{R}_{\mathrm{co}} / 20 \text { ) Conductors (ACSR and AACSR) } \\
& \left(\mathrm{R}_{\alpha} / \mathrm{t}\right)=\left\{1+\mathrm{a}\left(\mathrm{t}_{\mathrm{c}}-20\right)\right\} \Omega / \mathrm{km} \text { where. } \\
& a=0.004 \text { for Aluminium (Ec grade) and ACSR } \\
& \mathrm{a}=0.0036 \text { for AAAC and AACSR. } \\
& \left(R_{o d} / t_{\mathrm{t}}\right)=R_{\Delta d} / \mathrm{t}_{\varepsilon}\left\{1+0.00519(\mathrm{mr})^{\circ} \mathrm{K}_{1}+\mathrm{K}_{2}\right\} \text { where, } \\
& \mathrm{mr}=0.050133\left\{\mathrm{f} /\left(\mathrm{R}_{\delta /} / \mathrm{t}\right)\right\}^{1 / 2} \\
& =0.3544938 /\left(R_{\alpha} / t_{\alpha}\right)^{1 / 2} \\
& \text { if } \mathrm{mr}<2.8 \\
& \mathrm{n}=40.0616+0.0896(\mathrm{mr}) \quad 0.0513(\mathrm{mr})^{2} \\
& \text { if } \mathrm{mr}>2.8<5.0 \\
& \mathrm{n}=4+0.5363-0.2949(\mathrm{mr})+0.0097(\mathrm{mr})^{2} \\
& \mathrm{~K}_{1} \quad=\left[\cos \left\{90(\mathrm{~d} / \mathrm{D})^{p}\right\}\right]^{235} \text { where. } \\
& P=0.7+0.11(\mathrm{mr}) 0.04(\mathrm{mr})^{2}+0.0094(\mathrm{mr})^{3} \\
& \mathrm{~K}_{2}=0.15 \text { for single aluminium layer ACSR and AACSR } \\
& =0.03 \text { for three aluminium layer ACSR and AACSR } \\
& =0.003 \text { for two or four aluminium layer ACSR and AACSR }
\end{aligned}
$$

### 3.5.2 Monometal conductor (AAC and AAAC)

$$
\begin{aligned}
\left(\mathrm{R}_{\mathrm{ed}} / \mathrm{t}_{\mathrm{d}}\right) & =\left(\mathrm{R}_{\mathrm{d}} / \mathrm{t}_{\mathrm{t}}\right)\left(1-Y_{)}\right) \text {where, } \\
Y_{\mathrm{s}} & =\left(X_{\mathrm{S}}\right) 4 /\left\{192+0.8\left(X_{j}\right) 4\right\} \text { where } \\
X_{\mathrm{s}}^{2} & =3 \pi f 10^{2} /\left(R_{\mathrm{d} /} / \mathrm{t}_{\mathrm{t}}\right) \\
& =0.1256637 /\left(R_{\mathrm{s}} / \mathrm{t}_{\mathrm{e}}\right) \text { for } \mathrm{f}=50 \mathrm{~Hz}
\end{aligned}
$$

### 3.6 Current carrying capacity of conductor

। $=\left\{\frac{\left(W_{c}+W_{1} W_{2}\right)}{\left(R_{\sigma / t}\right) \times 10^{3}}\right\}^{1 / 2}$

## Reference

1. Current Carrying capacity of overhead transmission line conductor for Northern Region CBIP Publication
2. Ampacities for Aluminium and ACSR and overhead Electric conductors Aluminium Association, New York.
3. Current temperature characteristics of Aluminium conductors Alcoa publication, Pittsburgh
4. Design and Construction guide line-Swed Power publication
5. IEEE Standard for calculation of bare overhead conductor temperature and Ampacity under steady state conditionsAmerican National Standard 738-1986

## AIR PARAMETERS

| Air film Temp. $\mathbf{t}_{\mathbf{~}}{ }^{\circ} \mathrm{C}$ | Abs. Viscosity of air $\mu_{\mathbf{1}}$ <br> $\mathbf{k g} / \mathbf{m} . \mathbf{h r .}$ | Air Density at sea level $\mathbf{P}_{\mathbf{f}}$ <br> $\mathbf{k g} / \mathbf{c u m}$ | Thermal Conductivity of air K <br> $\mathbf{W}$ |
| :---: | :---: | :---: | :---: |
| 0.00 | 0.061759 | 1.2927 | 0.024245 |
| 5.00 | 0.062650 | 1.2703 | 0.024606 |
| 10.00 | 0.063545 | 1.2478 | 0.025000 |
| 15.00 | 0.064438 | 1.2254 | 0.025361 |
| 20.00 | 0.065330 | 1.2046 | 0.025722 |
| 25.00 | 0.066074 | 1.1854 | 0.026083 |
| 30.00 | 0.066967 | 1.1661 | 0.026476 |
| 35.00 | 0.067860 | 1.1469 | 0.026837 |
| 40.00 | 0.068604 | 1.1277 | 0.027231 |
| 45.00 | 0.069497 | 1.1101 | 0.027592 |
| 50.00 | 0.070390 | 1.0941 | 0.027953 |
| 55.00 | 0.071134 | 1.0764 | 0.028346 |
| 60.00 | 0.072027 | 1.0588 | 0.028707 |
| 65.00 | 0.072771 | 1.0444 | 0.029068 |
| 70.00 | 0.073515 | 1.0300 | 0.029462 |
| 75.00 | 0.074408 | 1.0156 | 0.029823 |
| 80.00 | 0.075152 | 1.0044 | 0.030217 |
| 85.00 | 0.075896 | 0.98674 | 0.030577 |
| 90.00 | 0.076640 | 0.97393 | 0.030938 |
| 95.00 | 0.077533 | 0.95951 | 0.031234 |
| 100.00 | 0.078277 | 0.94669 | 0.031693 |

Intermediate Values may be interpolated

## EXAMPLES

Example 1: Ampacity of $54(\mathrm{Al})+/ .7(\mathrm{st}) / 3.18 \mathrm{~mm}$ "Zebra" AC

Data: | Conductor construction | $54(a / m)+7$ (Steel) $/ 3.18 \mathrm{~mm}$ ACSR |
| :--- | :--- |
| Conductor diameter (outer) | $\mathrm{D}=0.02862 \mathrm{~m}$ |
| Conductor diameter (inner) | $\mathrm{d}=0.00954 \mathrm{~m}$ |
| Conductor dc resistance at $20^{\circ} \mathrm{C}$ | $\mathrm{R}_{\mathrm{a} d} / 20=0.06915 \Omega / \mathrm{km}$ |
| Solar absorption Coefficient | $\mathrm{a}=0.8$ |
| Emissivity Coefficient | $\mathrm{a}=0.45$ |
| Final Conductor Temp. | $\mathrm{t}_{\mathrm{a}}=75^{\circ} \mathrm{C}$ |
| Final Conductor Temp. | $\mathrm{K}=348 \mathrm{~K}$ |
| Ambient Temp. | $\mathrm{t}_{\mathrm{a}}=40^{\circ} \mathrm{C}$ |
| Ambient Temp. | $\mathrm{K}=313 \mathrm{~K}$ |
| Solar radiation | $\mathrm{S}=1164 \mathrm{Watts} / \mathrm{Sq} . \mathrm{m}$. |
| Wind Velocity | $\mathrm{V}=2200 \mathrm{~m} / \mathrm{hr}$ |

1 Heat gained by solar irradiation (W)

$$
W_{s}=a S D=0.8 \times 1164 \times 0.02862=26.650944 \mathrm{~W} / \mathrm{m}
$$

2 Heat lost radiation $\left(W_{T}\right)$

$$
\begin{aligned}
W_{,} & =0.17838 \times 10^{-6}\left(\mathrm{Kc}^{4} \mathrm{Ka}^{4}\right) \times \mathrm{D} \times \mathrm{e} \\
& =0.17838 \times 10^{6} \times\left(348^{4}-313^{6}\right) \times 0.02862 \times 0.45=11.643584 \mathrm{~W} / \mathrm{m}
\end{aligned}
$$

## 3 Heat lost by convection ( $W_{5}$ )

Average Temp. $\mathrm{t}_{1}=\left(\mathrm{t}_{\mathrm{e}}+\mathrm{t}_{2}\right) / 2=(75+40) / 2=57.5^{\circ} \mathrm{C}$
From Table 1, by interpolation

| $\mu_{1}$ | $=$ | 0.0715806 |
| :---: | :---: | :---: |
| $P_{1}$ | $=$ | 1.0676 |
| K | $=$ | 0.0285265 |
| $\checkmark$ | $=$ | $2200 \mathrm{~m} / \mathrm{hr}$ (from data) |
| (Dp,V)/f | $=$ | $(0.02862 \times 1.0676 \times 2200) / 0.0715806=939.08638$ |
| $\mathrm{W}_{\text {er }}$ | $=$ $=$ $=$ | $\begin{aligned} & \left\{1.00531+1.35088(\mathrm{Dp}, \mathrm{~V} / \mathrm{m})^{058}\right\} K_{1} \times\left(\mathrm{t}_{0}-\mathrm{t}_{\mathrm{j}}\right) \\ & \left\{1.00531+1.35088 \times(939.08638)^{552}\right\} \times 0.0285265 \times(75-40) \\ & 48.399565 \mathrm{~W} / \mathrm{m} \end{aligned}$ |
| $W_{\text {a }}$ | $=$ $=$ $=$ | $\begin{aligned} & \left\{0.75398 \times(\mathrm{Dp}, V / \mu)^{0.6}\right\} \times K_{1} \times\left(\mathrm{t}_{\mathrm{t}}-\mathrm{t}_{\mathrm{t}}\right) \\ & \left\{0.75398 \times(939.08638)^{0.6}\right\} \times 0.0285265 \times(75-40) \\ & 45.740731 \mathrm{~W} / \mathrm{m} \end{aligned}$ |

Therefore,
$\mathrm{W}_{\mathrm{c}} \quad=\quad 48.399565 \mathrm{~W} / \mathrm{m}$ (Higher of the two values)
4 Conductor AC resistance at final temperature
$\mathrm{R}_{d \mathrm{~d}} / \mathrm{t}_{\mathrm{c}} \quad=\quad \mathrm{R}_{d d} / 75=\mathrm{R}_{\mathrm{dd}} / 20\{1+0.004(75-20)\}$
Therefore,

| $\mathrm{R}_{\mathrm{d} /} / 75$ | $=$ | $0.06915 \times 1.22$ | $=0.084363 \Omega / \mathrm{km}$ |
| :---: | :---: | :---: | :---: |
| d/D | $=$ | $(3.18 \times 3) /(3.18 \times 9)$ | $=3 / 9$ |
| mr | $=$ | $0.050133\left\{\mathrm{f} /\left(\mathrm{R}_{\text {de }} / \mathrm{t}\right)\right\}^{1 / 2}$ | $\mathrm{f}=50 \mathrm{H}_{3}$ |
|  | $=$ | $0.3544938 /(0.084363)^{1 / 2}$ | $=1.2204855<2.8$ |

Therefore,

| n | $=$ | $4 \cdot 0.0616+0.0896(\mathrm{mr}) \cdot 0.0513(\mathrm{mr})^{2}$ |
| :---: | :---: | :---: |
|  | $=$ | $4-0.0616+0.0896 \times 1.2204855-0.0513(1.2204855)^{2}$ |
|  | $=$ | 3.9713398 |
| $p$ | $=$ | $0.7+0.11(\mathrm{mr})-0.04(\mathrm{mr})^{2}+0.0094(\mathrm{mr})^{3}$ |
|  | $=$ | $0.7+0.11(1.2204855)-0.04(1.2204855)^{2}+0.0094(1.2204855)^{3}$ |
|  | $=$ | 0.7917593 |
| $K_{1}$ | $=$ | $\left[\operatorname{Cos}\left\{90 \times(\mathrm{d} / \mathrm{D})^{0}\right\}\right]^{235}$ |
|  | $=$ | $\left[\operatorname{Cos}\left\{90 \times(3 / 9)^{0090963}\right\}\right]^{235}$ |
|  | $=$ | 0.5765547 |
| $\mathrm{K}_{2}$ | $=$ | 0.03 (for 3 aluminium layer ACSR) |
| $\mathrm{R}_{\mathrm{uc}} / \mathrm{t}_{\mathrm{c}}$ | $=$ | $\mathrm{R}_{\mathrm{ad}} / \mathrm{t}_{\mathrm{c}}\left(1+0.00519(\mathrm{mr})^{n} \mathrm{~K}_{1}+\mathrm{K}_{2}\right)$ |
| Therefore |  |  |
| $\mathrm{R}_{\mathrm{ad}} / 75$ | $=$ | $\mathrm{Rad}_{\mathrm{ad}} / 75\left\{1+0.00519(\mathrm{mr})^{n} \mathrm{~K}_{1}+\mathrm{K}_{2}\right\}$ |
|  | $=$ | $0.084363\left\{1+0.00519 \times(1.2204855)^{3973898} \times 0.5765547+0.03\right\}$ |
|  | $=$ | $0.0874508 \Omega / \mathrm{km}$ |

## 5 Current Carrying Capacity

$1=\left\{\left(W_{c}+W_{R}-W_{\mathrm{c}}\right) /\left(R_{\mathrm{s}} / \mathrm{t}_{\mathrm{c}} \times 10^{3}\right)\right\}^{1 / 2}$
$=\left\{(48.399565+11.643584 \cdot 26.650944) / 0.0874508 \times 10^{3}\right\}^{n}$
$=617.93196$ or say 618 Amps.

## Example 2

Ampacity of AAAC Conductor of Same construction 61/3.18 mm

```
\(\mathrm{R}_{\mathrm{ce}} / 20=0.0705402\) (maximum) \(\Omega / \mathrm{km}\)
\(\mathrm{R}_{\mathrm{ud}} / 75=0.0705402 \times\{1+0.0036(75-20)\}\)
    \(=0.0845071 \Omega / \mathrm{km}\)
\(X_{s}^{2} \quad=4 \pi 10^{2} /\left(R_{d d} / 75\right) \quad=4 \rho 10^{2} / 0.0845071 \quad=1.4870178\)
\(Y_{s} \quad=\quad X_{0}^{t} /\left\{192+0.8 \times_{5}^{t}\right\} \quad=0.0114116\)
\(\mathrm{R}_{\mathrm{ed}} / 75=\quad \mathrm{R}_{\mathrm{d} \alpha} / 75\left(1+Y_{\mathrm{s}}\right)=0.0854714 \Omega / \mathrm{km}\)
```


## Current Carrying Capacity

$=\left\{33.392205 /\left(0.0854714 \times 10^{3}\right)\right\}^{1 / 2}$
$=625.04623 \mathrm{Amps}$ or say, 625 Amps .

## Inference

a. AAAC can carry $1.13 \%$ higher current than ACSR of same construction and size, for the same maximum temperature.
b. AAAC has $2.26 \%$ lesser energy loss than ACSR of same construction and size, the same current.

## SAG AND TENSION IN CONDUCTORS

1 Indian Electricity Rules 1956, IS 802/1977 and IS 5613/1985 specify the following maximum limits of tension in conductors of transmission lines.
a. At minimum temperature and $2 / 3$ maximum wind pressure $50 \%$
b. At every day temperature of $32{ }^{\circ} \mathrm{C}$ and maximum wind pressure $\quad 50 \%$
c. At every day temperature of $32^{\circ} \mathrm{C}$ and still wind $\quad 25 \%$
I. E. Rules 77 to 80 \& 87, the PTCC Manual and The Railway Regulations 1987 for placing power lines across tracks specify the minimum clearance from the nearest power conductor to ground, to buildings, between power lines, over telecom lines and over rail tracks, etc.

IS $5613 / 85$ further stipulates that the maximum sag in the ground wire (Earth wire) shall not exceed 90 percent of sag in power conductor for the entire operating temperature range, under steel wind.
2 A simple, step by step method of calculating sags and tensions in conductors and ground wires for different operating temperatures and wind conditions is given below. Parabolic formula is adopted as commonly in use.
3 Symbols

| D | $=$ | Overall diameter of conductor ( m ) |
| :---: | :---: | :---: |
| A | $=$ | Cross sectional area of conductor (Sq. cm) |
| W | $=$ | Linear mass of conductor ( $\mathrm{Kgf} / \mathrm{m}$ ) |
| $\delta$ | $=$ | Linear mass of conductor per meter per unit sectional area |
|  | $=$ | W/A Kgf/Sq. cm/m |
| U | $=$ | Ultimate tensile strength of conductor (Kgf) |
| E | $=$ | Modulus of Elasticity (final) of conductor (Kgf/Sq. cm) |
| $\alpha$ | $=$ | Coefficient of linear expansion of conductor (per ${ }^{\circ} \mathrm{C}$ ) |
| L | $=$ | Span (m) |
| $P_{1}$ | $=$ | Maximum wind pressure on conductor (Kgt/ sq. m) |
| $\mathrm{P}_{2}$ | $=$ | Wind load on conductor at minimum temperature, per meter length (kgt/m) |

### 4.1 Weight Factor

$\delta=$ W/A $(\mathrm{kg} / \mathrm{sq} . \mathrm{cm} / \mathrm{m})$
4.2 Wind factors

$$
\begin{array}{lll}
\text { (a) Wind pressure } & & \mathrm{P}_{1}=\mathrm{Kgf} / \mathrm{sq} \cdot \mathrm{~m} \\
\text { (b) } & \text { Wind load } & 2 / 3 \mathrm{Max} .
\end{array} \mathrm{P}_{2}=2 / 3 \mathrm{P}_{1} \times \delta \times 1(\mathrm{kgf} / \mathrm{m}) .
$$

## Loading factors:

Still wind
2/3 full wind
Full wind

$$
\begin{aligned}
& q_{1}=1 \\
& q_{2}=\left\{1+\left(P_{2} / W\right)^{2}\right\}^{n} \\
& a_{3}=\left\{1+\left(P_{3} / W\right)^{2}\right\}^{1 / 2}
\end{aligned}
$$

Temperature factors
$E \alpha t=E \alpha\left(t_{2}-t_{1}\right)$
Tension factors
Still wind condition $\quad=\frac{L^{2} \delta^{2} E q}{24}$
$2 / 3$ full wind condition

$$
=\frac{\mathrm{L}^{2} \delta^{2} \mathrm{Eq}_{2}^{2}}{24}
$$

Full wind condition

$$
=\frac{\mathrm{L}^{2} \delta^{2} \mathrm{Eq}_{3}^{2}}{24}
$$

Sag factors
Still wind condition

$$
=\frac{L^{2} \delta E q_{1}}{8}
$$

4.7

Parameters
Calculation of the following parameters before hand makes further calculations simpler and easier.

$$
=\frac{L^{2} \delta E q_{2}}{8}
$$

$$
=\frac{\mathrm{L}^{2} \delta E \mathrm{q}_{3}}{8}
$$

$P_{3}=\quad$ Wind load on conductor at $32{ }^{\circ} \mathrm{C}$ per meter length (Kgf/m)
$t_{1}=\quad$ Initial conductor temperature $\left({ }^{\circ} \mathrm{C}\right)$
$\mathrm{t}_{2}=\quad$ Final conductor temperature $\left({ }^{\circ} \mathrm{C}\right)$
$\mathrm{Q}_{1}=\quad$ Still wind loading factor (1)
$\mathrm{Q}_{2} \quad=\quad 2 / 3$ Maximum wind loading factor
$\mathrm{Q}_{3}=\quad$ Maximum wind loading factor
$\mathrm{f}_{1}=\quad$ Initial stress in conductor at temperature $\mathrm{t} 1 \mathrm{Kg} / \mathrm{sq} . \mathrm{m}$ (Tension per unit area)
$\mathrm{f}_{2}=\quad$ Final stress in conductor at temperature $\mathrm{t} 2(\mathrm{Kgf} / \mathrm{Sq} . \mathrm{cm})$
$\mathrm{T}_{1}=\quad$ Initial tension in conductor at temperature $\mathrm{t}_{1}=\mathrm{f}_{1} \times \mathrm{a}(\mathrm{Kgf})$
$T_{2}=\quad$ Final tension in conductor at temperature $t_{2}=f_{2} \times a(K g f)$
$\mathrm{K}=\quad$ Stress Constant
$\mathrm{S}_{1}=\quad$ Sag at initial condition $T_{1}(\mathrm{~m})$
$\mathrm{S}_{2}=\quad$ Sag at final condition $\mathrm{T}_{2}(\mathrm{~m})$

## EXAMPLE

### 5.1 Data

5.1.1 Conductor 61/3. 19 mm AAAC

| Overall diameter | D | $=$ | 0.02871 m |
| :--- | :--- | :--- | :--- |
| Sectional Area | A | $=$ | $4.875 \mathrm{Sq} \cdot \mathrm{cm}$. |
| Weight | W | $=$ | $1.345 \mathrm{~kg} / \mathrm{m}$ |
| Ultimate Tensile Strength (UTS) | $U$ |  | $=$ |
| Modulus of Elasticity (final ) | E | $=$ | 13154 Kgf |
| Coefficients of Linear Expansion | a | $=$ | $0.55 \times 10^{6} \mathrm{Kgf} / \mathrm{sq} \cdot \mathrm{m}$ |
|  |  | $23 \times 10^{6} . \mathrm{per}{ }^{\circ} \mathrm{C}$. |  |

Limiting tension

| $32^{\circ} \mathrm{C}$ nil wind | $25 \%$ UTS |
| :--- | :--- |
| $0^{\circ} \mathrm{C} 2 / 3$ full wind | $50 \%$ UTS |
| $32^{\circ} \mathrm{C}$ full wind | $50 \%$ UTS |

5.1.2 Normal span
$\mathrm{L}=350 \mathrm{~m}$
5.1.3 Maximum wind pressure
$P_{1}=45 \mathrm{Kgf} / \mathrm{sq} . \mathrm{m}$
5.1.4 Initial conductor temperature
$t_{1}=32^{\circ} \mathrm{C}$
5.1.5 Final conductor temperature $\mathrm{t}_{2}$

Minimum $\quad 0^{\circ} \mathrm{C}$
Intermediate $\quad 32^{\circ} \mathrm{C}$
Intermediate $\quad 53^{\circ} \mathrm{C}$
Maximum $\quad 75^{\circ} \mathrm{C}$
5.2 Parameters
5.2.1 Weight factor

$$
\begin{aligned}
\delta & =W / A \\
& =1.345 / 4.875 \\
& =0.2759(\mathrm{~kg} / \mathrm{Sq} . \mathrm{cm} / \mathrm{m})
\end{aligned}
$$

5.2 .2 a) Wind load on conductor

| At 2/3 Maximum wind pressure | $P_{2}$ |  |  |
| ---: | :--- | :--- | :--- |
|  |  |  | $2 / 3 \times 45 \times 0.02871 \times 1$ |
|  |  |  | $\underline{0.8613(\mathrm{~kg} / \mathrm{m})}$ |
| At Maximum wind pressure | $P_{3}$ |  | $=$ |
|  |  |  | $45 \times 0.02871 \times 1$ |
|  |  | $\underline{1.2920(\mathrm{~kg} / \mathrm{m})}$ |  |

b) Wind factors

$$
\begin{aligned}
\text { Still wind } \mathrm{a}_{1} & =1 \\
2 / 3 \text { Max. wind } \mathrm{a}_{2} & =\left\{1+\left(\mathrm{P}_{2} / w\right)^{2}\right\}^{1 / 2} \\
& =\left\{1+(0.8613 / 1.345)^{2}\right\}^{1 / 2} \\
& =1.1875 \\
\text { Full wind } \mathrm{a}_{3} & =\left\{1+\left(\mathrm{P}_{3} / W^{2}\right\}^{1 / 2}\right. \\
& =\left\{1+(1.2920 / 1.345)^{2}\right\}^{1 / 2} \\
& =1.3866
\end{aligned}
$$

### 5.2.3 Temperature Factors

| $E \alpha t_{3 e}$ | $=0\left(\right.$ Starting condition assumed at $\left.32^{\circ} \mathrm{C}\right)$ |
| :--- | :--- |
| $E \alpha t_{0}$ | $=0.55 \times 10^{6} \times 23 \times 10^{6} \times(0-32)=(-) 404.80$ |
| $E \alpha t_{53}$ | $=0.55 \times 10^{6} \times 23 \times 10^{6} \times(53-32)=265.65$ |
| $E \alpha t_{25}$ | $=0.55 \times 10^{6} \times 23 \times 10^{6} \times(75-32)=543.95$ |
| $E \alpha t_{50}$ | $=0.55 \times 10^{6} \times 23 \times 10^{6}(90-32)=733.70$ |

### 5.2.4 Tension Factors

| At still wind $\left(\mathrm{L}^{2} \delta^{2} \mathrm{E}\left(\mathrm{q}_{1}\right)^{2}\right) / 24$ |  |  | $350^{2} \times 0.2759^{2} \times 0.55 \times 10^{6} \times 1 / 24$ |
| ---: | :--- | ---: | :--- |
|  |  | $213.6933 \times 10^{6}$ |  |
| At $2 / 3$ full wind $\left(\mathrm{L}^{2} \delta^{2} \mathrm{E}\left(\mathrm{q}_{2}\right)^{2}\right) / 24$ |  |  | $213.6933 \times 10^{6} \times 1.1875^{2}$ |
|  |  | $301.3238 \times 10^{5}$ |  |
| At full wind $\left(\mathrm{L}^{2} \delta^{2} \mathrm{E}\left(\mathrm{q}_{2}\right)^{2}\right) / 24$ |  | $=$ | $213.6933 \times 10^{6} \times 1.38666^{2}$ |
|  | $=$ | $410.8595 \times 10^{5}$ |  |

### 5.2.5 Sag Factors

| At still wind $\left(\mathrm{L}^{2} \delta \mathrm{q}_{1}\right) / 8$ | $=$ | $(3502 \times 0.2759 \times 1) / 8$ |
| ---: | :--- | :--- |
|  | $=$ | 4224.7188 |
| At 2/3 full wind $\left(\mathrm{L}^{2} \delta \mathrm{q}_{2}\right) / 8$ | $=$ | $4224.7188 \times 1.1875$ |
|  | $=$ | 5016.8535 |
| At full wind $\left(\mathrm{L}^{2} \delta \mathrm{q}_{3}\right) / 8$ | $=$ | $4224.7188 \times 1.3866$ |
|  | $=$ | 5857.9950 |

5.3 Sags and Tensions

For most conductors, the tension limitation at $32^{\circ} \mathrm{C}$, still wind is the control ling factor. Hence the same is assumed as the starting condition.
5.3.1 At $32{ }^{\circ} \mathrm{C}$ still wind (Starting condition Assumed)

| $\mathrm{T}_{1}$ | $=\mathrm{U} / 4$ | $=13154 / 4$ |
| ---: | :--- | :--- |
|  |  | $=3288.50 \mathrm{kgf}$ |
| $\mathrm{f}_{1}$ | $=\mathrm{T}_{1} / \mathrm{A}$ |  |
|  |  | $=3288.50 / 4.875$ |
|  | $=674.5641$ |  |
|  | $=\mathrm{kgf} / \mathrm{Sq} \cdot \mathrm{cm}$ |  |
| $\mathrm{S}_{1}$ | $=\left(\mathrm{L}^{2} \delta \mathrm{q}_{1}\right) / 8 \mathrm{~F}_{1}$ | $=4224.7188 / 674.5641$ |
|  |  | $=6.2629 \mathrm{~m}$ |
| Result $\quad \mathrm{T}_{32} / \mathrm{q}_{1}$ |  | $=3288 \mathrm{kgf}$ |
|  | $\mathrm{S}_{32} / \mathrm{q}_{1}$ |  |
|  | $=6.26 \mathrm{~m}$ |  |

We now find stress constant $K$ given by the formula

| $K$ | $=t_{1} \cdot\left(L^{2} \delta^{2} \mathrm{Eq}_{3}{ }^{2}\right) / 24 f_{1}{ }^{2}$ |
| ---: | :--- |
|  | $=674.5641-\left(213.6933 \times 10^{6}\right) /(674.5641)^{2}=204.9464$ |
| $K$ | $=204.9464$ |

5.3.2 At $53^{\circ} \mathrm{C}$ still wind

| $\mathrm{f}_{2}^{2}$ | $\left\{\mathrm{f}_{2}-\left(\mathrm{K}-E \boldsymbol{\alpha} \mathrm{t}_{53}\right)\right\}$ | $=\left(\mathrm{L}^{2} \delta^{2} \mathrm{Eq}_{1}^{2}\right) / 24$ |
| :--- | :--- | :--- |
| $\mathrm{f}_{2}^{2}$ | $\left\{\mathrm{f}_{2}-(204.9464-265.65)\right\}$ | $=213.6933 \times 10^{6}$ |
| $\mathrm{f}_{2}^{2}$ | $\left\{\mathrm{f}_{2}+(60.7036)\right\}$ | $=213.6933 \times 10^{6}$ |

By trial and error with the help of a Scientific calculator

| $\mathrm{f}_{2}$ | $=578.2914 \mathrm{kgf} / \mathrm{sq} \cdot \mathrm{m}$ |  |
| ---: | :--- | ---: |
| $\mathrm{T}_{2}$ | $=\mathrm{F}_{2} \times \mathrm{A}$ |  |
|  | $=578.2914 \times 4.875$ |  |
|  | $=2819.1705 \mathrm{kgf}$ |  |
| Sag $\mathrm{S}_{2}$ | $=\left(\mathrm{L}^{2} \delta q_{1}\right) / 8 \mathrm{f}_{2}$ |  |
|  | $=4224.7188 / 578.2914$ |  |
|  | $=7.3055 \mathrm{~m}$ | $=2819 \mathrm{kgf}$ |
| Result | $\mathrm{T}_{55} / \mathrm{q}_{1}$ | $=7.31 \mathrm{~m}$ |

5.3.3 At $75^{\circ} \mathrm{C}$ still wind

| $\mathrm{f}_{2}{ }^{2}\left\{\mathrm{f}_{2}-\left(\mathrm{K}-\mathrm{Eat}_{75}\right)\right\}$ | $=\left(\mathrm{L}^{2} \delta^{\hat{2}} \mathrm{Eq}_{1}{ }^{2}\right) / 24$ |
| :---: | :---: |
| $\mathrm{f}_{2}{ }^{2}\left\{\mathrm{f}_{2}-(204.9464-543.95)\right\}$ | $=213.6933 \times 10^{6}$ |
| $\mathrm{f}_{2}{ }^{2}\left\{\mathrm{f}_{2}+339.0036\right\}$ | $=213.6933 \times 10^{6}$ |
| $\mathrm{f}_{2}$ | $=503.5983 \mathrm{kgf} / \mathrm{Sq} . \mathrm{cm}$ |
| $\mathrm{T}_{2}$ | $=F_{2} \times \mathrm{A}=503.5983 \times 4.875=2455.0417 \mathrm{kgf}$ |
| Sag S 2 | $=\left(\mathrm{L}^{2} \delta \mathrm{q}_{1}\right) / 8 \mathrm{f}_{2}=4224.7188 / 503.5983=8.3891 \mathrm{~m}$ |
| Result | $\mathrm{T}_{78} / \mathrm{q}_{1} \quad=2455 \mathrm{kgf}$ |
|  | $\mathrm{S}_{75} / \mathrm{q}_{1} \quad=8.39 \mathrm{~m}$ |

5.3.4 At $90^{\circ} \mathrm{C}$ NIL wind condition

| $\mathrm{f}_{2}{ }^{2}\left\{\mathrm{f}_{2}-\left(\mathrm{K}-\mathrm{E}^{\prime} \mathrm{t}_{50}\right)\right\}$ | $=\left(\mathrm{L}^{2} \delta^{2} \mathrm{Eq}_{1}{ }^{2}\right) / 24$ |  |
| :---: | :---: | :---: |
| $\mathrm{t}_{2}^{2}\left\{\mathrm{t}_{2}-(204.9464-733.70)\right\}$ | $=213.6930 \times 10^{6}$ |  |
| $\mathrm{f}_{2}{ }^{2}\left\{\mathrm{f}_{2}+528.7536\right.$ | $=213.6930 \times 10^{6}$ |  |
| $\mathrm{f}_{2}$ | $=463.9624 \mathrm{Kgf} / \mathrm{Sq} . \mathrm{cm}$ |  |
| $\mathrm{T}_{2}$ | $\begin{aligned} & =f_{2} \times \mathrm{A} \\ & =463.9624 \times 4.875 \\ & =2261.8167 \mathrm{kgf} \end{aligned}$ |  |
| Sag S 2 | $=\left(L^{2} \delta q_{1}\right) / 8 \mathrm{t}_{2}$ | $=\frac{4224.7188}{463.9624}$ |
|  | $=9.1057 \mathrm{~m}$ |  |
| Result | $\mathrm{T}_{90} / \mathrm{q}_{1}$ | $=2262 \mathrm{kgf}$ |
|  | $\mathrm{S}_{90} / \mathrm{q}_{1}$ | $=9.11 \mathrm{~m}$ |

5.3.5 At $0^{\circ} \mathrm{C} 2 / 3$ full wind
$f_{2}^{2}\left\{\mathrm{f}_{2}-(\mathrm{K}-\right.$ Eat $\left.)\right\}$
$\mathrm{f}_{2}^{2}\left\{\mathrm{f}_{2}-(204.9464+404.80)\right\}$
$\left.f_{2}^{2}\{12-609.74674)\right\}$
$\mathrm{f}_{2}$
$\mathrm{~T}_{2}$
F.O.S

Sag (defected) $\mathrm{S}_{2} / \mathrm{d}$

Angle of defection a

Q
Sag (Vertical)

$$
\begin{aligned}
& =\left(\mathrm{L}^{2} \delta^{2} \mathrm{Eq}_{1}^{2}\right) / 24 \\
& =301.3238 \times 10^{6} \\
& =301.3238 \times 10^{6} \\
& =946.26446 \mathrm{kgf} / \mathrm{sq} \cdot \mathrm{~m} \\
& =f_{2} \times \mathrm{A} \\
& =946.26446 \times 4.875 \\
& =4613.0392 \mathrm{kgf} \\
& =\mathrm{U} / \mathrm{T}_{2}=13154 / 4613 \\
& =2.8515>2.00 \mathrm{~min} . \text { required } \\
& =\left(\mathrm{L}^{2} \delta \mathrm{~g}_{3}\right) / 8 \mathrm{f}_{2} \\
& =5016.8535 / 946.2645 \\
& =5.3017 \mathrm{~m} \\
& =\tan ^{-1}\left(\mathrm{P}_{2} / \mathrm{W}\right) \\
& =\tan ^{-1}(0.8613 / 1.345) \\
& =32.6344 \text { degrees from vertical } \\
& =\mathrm{S}_{2} / \mathrm{N}=\mathrm{S}_{2} / \mathrm{d} \times \operatorname{Cos} \theta \\
& =5.3017 \mathrm{Cos}(32.6344) \\
& =4.4647 \mathrm{~m} \\
& \mathrm{~T}_{\mathrm{d}} / \mathrm{q}_{2} \\
& \mathrm{~S} / / \mathrm{q}_{2}
\end{aligned}
$$

5.3.6 53.6 At $32{ }^{\circ} \mathrm{C}$ full wind

$$
\begin{aligned}
& f_{2}^{2}\left\{f_{2}-\left(K-E \alpha \mathrm{H}_{3}\right)\right\} \\
& f_{2}^{2}\left\{f_{2}-(204.9464-0)\right\} \\
& \left.f_{2}^{2}\left\{f_{2}-204.9464\right)\right\} \\
& f_{2} \\
& T_{2}
\end{aligned}
$$

$$
=\left(\mathrm{L}^{2} \delta^{2} E a_{3}{ }^{2}\right) / 24
$$

F.O.S.
$=410.8595 \times 10^{6}$
$=410.8595 \times 10^{6}$
$=818.3889 \mathrm{kgf} / \mathrm{sq} . \mathrm{cm}$
$=\mathrm{f}_{2} \times \mathrm{A}$
$=818.3889 \times 4.875$
$=3989.6458 \mathrm{kgf}$
$=\mathrm{U} / \mathrm{T}_{2}$
$=13154 / 3989.6458$
$=3.297>2.00$ hence OK
Sag (deflected) S/d
$=\left(\mathrm{L}^{2} \delta \mathrm{q}\right) \mathrm{S} / 8 \quad \frac{4224.7188}{463.9624}$
$=$
angle of deflection $\theta$
$\theta$
Sag (Vertical)

Result
$=\tan ^{-1}\left(\mathrm{P}_{3} / \mathrm{W}\right)$
$=\tan ^{-1}(1.2920 / 1.345)$
$=43.8486$ degrees from vertical
$=S_{2} \mathrm{~N}$
$=S / d \operatorname{Cos} \theta$
$=7.1580 \operatorname{Cos}(43.8486)$
$=5.1622 \mathrm{~m}$
$\begin{array}{ll}\mathrm{T}_{32} / \mathrm{a}_{3} & =3990 \mathrm{kgf} \\ \mathrm{S}_{32} / \mathrm{a}_{3} & =5.16 \mathrm{~m}\end{array}$

## DICABS

## CURRENT CARRYING CAPACITY OF OVERHEAD CONDUCTORS

The continuous current carrying capacity of a conductor is limited by the conductor temperature rise above ambient air temperature to a maximum value that is considered safe under continuous operating conditions. For calculating the current ratings of overhead lines, ambient air temperature of $40^{\circ} \mathrm{C}$, is usually assumed. The maximum safe continuous operating temperature for bare conductor is limited to $100^{\circ} \mathrm{C}$ because of the effect of high temperatures on the mechanical properties of the conductor material, i.e., tensile strength and elongation. If aluminium wire is maintained at a constant temperature of $100^{\circ} \mathrm{C}$ for approx. 4 months, the limited amount of annealing which will take place will be sufficient to reduce the ultimate tensile strength of the aluminium strands, by amounts up to about $10 \%$. The actual amount varies for different wire sizes and those, which have the most cold work, and thus the highest ultimate tensile strength will suffer the greatest reduction.

The temperature rise curves given in the attached graphs apply to a wide range of conductors. These curves show current in Amperes as a function of conductor temperature rise above an ambient air temperature of $40^{\circ} \mathrm{C}$ with cross wind velocity of 0.061 meter per second.

## TYPICAL STRESS - STRAIN CURVES

AAAC - HS CURRENT CARRYING CAPACITY


## LOADING CONDITIONS



To avoid breaking of conductors under severe weather conditions, they must be installed with certain predetermined tensions. The loading on a conductor's is the resultant loading due to its weight and weight of any ice and the wind load. Certain formulae are available by which ice loads and wind on conductors can be calculated.
Weight of ice covering on conductor


Loading
True wind velocity is very difficult to measure and hence a correction factor must be applied to the wind velocity indicated by an anemometer.

The maximum wind pressure is calculated using the formula $F=K V^{2}$, where
$\mathrm{F}=$ wind pressure in $\mathrm{lb} . / \mathrm{sq}$. ft .
$V=$ actual wind velocity in miles per hour
The value $k$ is not strictly constant and depends on the shape and nature of the surface, barometric pressure and wind velocity. The following approximate values are used:
For cylindrical surfaces $\mathrm{k}=0.0025$
For flat surfaces $k=0.0042$



## BASIC DATA ASSUMED FOR CALCULATION

1. Sag - tension

| Conductor Type | $\begin{gathered} \hline \text { Construction (AL + ST) / } \\ \text { AAA } \\ \text { Wire Nos. / Nos. } \\ \hline \end{gathered}$ | Mod. of Elasticity $\mathrm{kg} / \mathrm{sq}$. cm | Co-Effi. of linear expansion per ${ }^{\circ} \mathrm{C}$ |
| :---: | :---: | :---: | :---: |
| ACSR | $6+1$ | $0.8055 \times 10^{6}$ | $19.1 \times 10^{-6}$ |
|  | $6+7$ | $0.7750 \times 10^{6}$ | $19.8 \times 10^{-6}$ |
| \& | $26+7$ | $0.8158 \times 10^{6}$ | $18.9 \times 10^{6}$ |
|  | $30+7$ | $0.8158 \times 10^{6}$ | $17.8 \times 10^{6}$ |
| AACSR | $42+7$ | $0.7546 \times 10^{6}$ | $21.5 \times 10^{6}$ |
|  | $54+7$ | $0.7036 \times 10^{6}$ | $19.3 \times 10^{6}$ |
| AAAC | 3 | B) $0.6500 \times 10^{6}$ | $23.0 \times 10^{6}$ |
|  | 7 | A) $0.6000 \times 10^{6}$ | $23.0 \times 10^{6}$ |
| \& | 7 | B) $0.6324 \times 10^{6}$ | $23.0 \times 10^{6}$ |
|  | 19 | A) $0.5700 \times 10^{6}$ | $23.0 \times 10^{6}$ |
| ACAR | 37 | A) $0.5700 \times 10^{6}$ | $23.0 \times 10^{6}$ |
|  | 37 | B) $0.5814 \times 10^{6}$ | $23.0 \times 10^{6}$ |
|  | 61 | A) $0.5500 \times 10^{6}$ | $23.0 \times 10^{6}$ |
|  | 61 | B) $0.5508 \times 10^{6}$ | $23.0 \times 10^{6}$ |

(A) AAAC to IS 398 (Part 4 1979) (Second Revision) \& ACAR
(B) AAAC to IS 398 (Part 4 1994) (Third Revision)
(2) Current Carrying Capacity:

| Solar Absorption Constant | $\mathrm{A}=0.5$ |
| :--- | :--- |
| Emissivity Constant | $\mathrm{E}=0.5$ |
| Solar Irradiation | $\mathrm{S}=985$ Watts $/ \mathrm{Sq} . \mathrm{m}$. |
| Wind Velocity | $\mathrm{V}=2200 \mathrm{M} / \mathrm{Hr}$. |
| Ambient Temperature | $\mathrm{Ta}=40^{\circ} \mathrm{C}$ |
| Height | MSL |

## CONFIGURATION DRAWINGS FOR AAC, AAAC \& ACSR

## CONFIGURATION DRAWINGS FOR AAC, AAAC \& ACSR



61 Al.

All Aluminium Conductors


Aluminium Alloy Conductors


$$
\frac{4-\mathrm{Al} .}{3-\text { Steel }}
$$


$\frac{15-\mathrm{Al} .}{4-\text { Steel }}$


$$
\frac{\text { 3-Al. }}{4 \text { Steel }}
$$


$\frac{12-\mathrm{Al} .}{7-\text { Stee }}$

$\frac{33 \cdot \mathrm{Al}}{4 \cdot \text { Steel }}$

$\frac{30-\mathrm{Al}}{7-\text { Steel }}$

$\frac{24-\mathrm{Al}}{13 \text { Steel }}$

$\frac{18-\mathrm{Al}}{19 \text {-Stee }}$

$\frac{54-\mathrm{Al}}{7-\text { Steel }}$

$\frac{48-\mathrm{Al} .}{13 \text {-Steel }}$

$\frac{42-\mathrm{Al}}{19 \text {-Steel }}$

Oluminium Wire
Typical Strandings for Concentric Lay-Stranded ACSR Conductors


Compressed Aluminium Conductor Steel Reinforced and All Aluminium Conductor

## VARIOUS INDIAN STANDARDS

ALL ALLUMINIUM ALLOY CONDUCTORS (AAAC) REC. spn. 33/1991 (R) \& Sizes to IS 398 (Part IV): 1994

## Mechanical Parameters

| $\begin{aligned} & \hline \mathrm{Sr} \\ & \mathrm{No} \end{aligned}$ | EQVT. ACSR Code | Nom. Alloy Area | Stranding and wire diameter | Section Area | Approximate |  | Rated Strength |  | Span | Tension |  |  |  | Sag |  |  |
| :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: |
|  |  |  |  |  |  |  | $32^{\circ} \mathrm{C}$ | $0^{\circ} \mathrm{C}$ with wind |  |  | $\begin{array}{\|c\|c\|c} 53^{\circ} \mathrm{C}\left\|75^{\circ} \mathrm{C}\right\| 90^{\circ} \mathrm{C} \\ \hline \text { Nil wind } \end{array}$ |  |  |
|  |  |  |  |  | OD | Mass |  |  |  |  |  |  |  |  |
|  |  | sq. m | Nos./mm | sq. mm | mm | kg/km | kn. | Kgf |  | m | Kgf | Kgf | Kgf | Kgf | m | m | m |
|  |  |  |  |  |  |  |  |  |  |  | Wind pressure kg/sq. m |  |  |  |  |  |
|  |  |  |  |  |  |  |  |  |  |  | 50 | 75 | 100 |  |  |  |
| 1 | Mole | 15 | 3/2.50 | 14.73 | 5.39 | 40 | 4.33 | 442 | 67 | 111 | 196 | 211 | 227 | 0.33 | 0.63 | 0.90 |
| 2 | Squirrel | 20 | 7/2.00 | 21.99 | 6.00 | 60 | 6.45 | 658 | $\begin{array}{r} 67 \\ 107 \\ \hline \end{array}$ | $\begin{aligned} & 165 \\ & 165 \\ & \hline \end{aligned}$ | $\begin{aligned} & 279 \\ & 292 \\ & \hline \end{aligned}$ | $\begin{aligned} & 292 \\ & 320 \end{aligned}$ | $\begin{aligned} & 309 \\ & 348 \\ & \hline \end{aligned}$ | $\begin{aligned} & 0.33 \\ & 0.79 \end{aligned}$ | $\begin{array}{\|l} \hline 0.61 \\ 1.25 \\ \hline \end{array}$ | $\begin{array}{r} 0.87 \\ 160 \mathrm{ss} \\ \hline \end{array}$ |
| 3 | Weasel | 34 | 7/2.50 | 34.36 | 7.50 | 94 | 10.11 | 1031 | $\begin{array}{r} 67 \\ 107 \\ \hline \end{array}$ | $\begin{aligned} & 258 \\ & 258 \\ & \hline \end{aligned}$ | $\begin{aligned} & 427 \\ & 440 \\ & \hline \end{aligned}$ | $\begin{aligned} & 442 \\ & 472 \\ & \hline \end{aligned}$ | $\begin{aligned} & 460 \\ & 506 \\ & \hline \end{aligned}$ | $\begin{aligned} & 0.32 \\ & 0.78 \end{aligned}$ | $\begin{aligned} & \hline 0.61 \\ & 1.24 \end{aligned}$ | $\begin{aligned} & 0.86 \\ & 1.59 \\ & \hline \end{aligned}$ |
| 4 | Rabbit | 55 | 7/3.15 | 54.55 | 9.45 | 149 | 16.03 | 1635 | $\begin{array}{r} \hline 67 \\ 107 \\ 125 \\ \hline \end{array}$ | $\begin{aligned} & 409 \\ & 409 \\ & 409 \\ & \hline \end{aligned}$ | $\begin{aligned} & 674 \\ & 686 \\ & 692 \\ & \hline \end{aligned}$ | $\begin{aligned} & 690 \\ & 721 \\ & 737 \\ & \hline \end{aligned}$ | $\begin{aligned} & \hline 710 \\ & 763 \\ & 788 \\ & \hline \end{aligned}$ | $\begin{array}{l\|} \hline 0.33 \\ 0.79 \\ 1.05 \\ \hline \end{array}$ | $\begin{array}{\|l\|} \hline 0.62 \\ 1.25 \\ 1.58 \\ \hline \end{array}$ | $\begin{aligned} & \hline 0.88 \\ & 1.61 \\ & 1.98 \\ & \hline \end{aligned}$ |
| 5 | Raccoon | 80 | 7/.3.81 | 79.81 | 11.43 | 218 | 23.41 | 2387 | 125 | 597 | 990 | 1040 | 1097 | 1.05 | 1.58 | 1.98 |
| 6 | Dog | 100 | 7/4.26 | 99.77 | 12.78 | 273 | 29.26 | 2984 | 125 | 746 | 1226 | 1278 | 1340 | 1.05 | 1.58 | 1.98 |
| 7 | Dog (up) | 125 | 19/2.89 | 124.60 | 14.45 | 342 | 36.64 | 3736 | 125 | 934 | 1507 | 1561 | 1627 | 1.05 | 1.56 | 1.95 |
|  |  |  |  |  |  |  |  |  |  |  | Wind pressure $\mathrm{kg} / \mathrm{sq} . \mathrm{m}$ |  |  |  |  |  |
|  |  |  |  |  |  |  |  |  |  |  |  |  | 52 |  |  |  |
| 8 | Dog (up) Coyote | 150 | 19/3.15 | 148.10 | 15.75 | 407 | 43.50 | 4436 | $\begin{array}{l\|} \hline 260 \\ 275 \\ \hline \end{array}$ | $\begin{aligned} & 1109 \\ & 1109 \\ & \hline \end{aligned}$ | $\begin{aligned} & 1743 \\ & 1740 \\ & \hline \end{aligned}$ | $\begin{array}{\|l} 1755 \\ 1753 \\ \hline \end{array}$ | $\begin{aligned} & 1798 \\ & 1800 \\ & \hline \end{aligned}$ | $\begin{aligned} & 3.92 \\ & 1.33 \\ & \hline \end{aligned}$ | $\begin{array}{\|l\|} \hline 4.85 \\ 5.30 \\ \hline \end{array}$ | $\begin{aligned} & 5.47 \\ & 5.95 \\ & \hline \end{aligned}$ |
| 9 | Wolf | 175 | 19/3.40 | 172.50 | 17.00 | 474 | 50.54 | 5154 | $\begin{aligned} & 260 \\ & 275 \\ & \hline \end{aligned}$ | $\begin{aligned} & 1289 \\ & 1289 \\ & \hline \end{aligned}$ | $\begin{array}{\|l\|} 2007 \\ 2002 \\ \hline \end{array}$ | $\begin{aligned} & 2020 \\ & 2015 \\ & \hline \end{aligned}$ | $\begin{aligned} & 2065 \\ & 2065 \\ & \hline \end{aligned}$ | $\begin{aligned} & 3.93 \\ & 4.34 \\ & \hline \end{aligned}$ | $\begin{array}{\|l\|} \hline 4.86 \\ 5.30 \\ \hline \end{array}$ | $\begin{array}{r} 5.49 \\ 5.96 \\ \hline \end{array}$ |
| 10 | Wolf (up) | 200 | 19/3.66 | 199.90 | 18.30 | 549 | 58.66 | 5982 | $\begin{aligned} & 260 \\ & 275 \\ & \hline \end{aligned}$ | $\begin{aligned} & 1496 \\ & 1496 \\ & \hline \end{aligned}$ | $\begin{aligned} & 2306 \\ & 2298 \\ & \hline \end{aligned}$ | $\begin{aligned} & 2319 \\ & 2312 \end{aligned}$ | $\begin{aligned} & 2366 \\ & 2363 \end{aligned}$ | $\begin{aligned} & 3.92 \\ & 4.34 \end{aligned}$ | $\begin{array}{\|l\|} \hline 4.85 \\ 5.30 \\ \hline \end{array}$ | $\begin{aligned} & 5.49 \\ & 5.95 \end{aligned}$ |
| 11 | Panther | 230 | 19/3.94 | 231.70 | 19.70 | 637 | 68.05 | 6939 | 320 | 1735 | 2609 | 2627 | 2693 | 5.69 | 6.76 | 7.47 |
| 12 | Panther (up) | 290 | 37/3.15 | 288.30 | 22.05 | 704 | 84.71 | 8638 | 320 | 2160 | 3163 | 3181 | 3249 | 5.68 | 6.73 | 7.43 |
| 13 | Panther (up) | 345 | 37/3.45 | 345.90 | 24.15 | 953 | 101.58 | 10358 | 320 | 2590 | 3754 | 3773 | 3844 | 5.68 | 6.73 | 7.43 |
| 14 | Kundah | 400 | 37/3.71 | 400.00 | 25.97 | 1102 | 117.40 | 11971 | $\begin{aligned} & 350 \\ & 380 \\ & \hline \end{aligned}$ | $\begin{aligned} & 2993 \\ & 2993 \\ & \hline \end{aligned}$ | $\begin{array}{\|l\|} \hline 4255 \\ 4207 \\ \hline \end{array}$ | $\begin{aligned} & 4277 \\ & 4232 \\ & \hline \end{aligned}$ | $\begin{aligned} & 4360 \\ & 4324 \\ & \hline \end{aligned}$ | $\begin{aligned} & 6.69 \\ & 7.76 \\ & \hline \end{aligned}$ | $\begin{array}{\|l\|} \hline 7.80 \\ 8.94 \\ \hline \end{array}$ | $\begin{aligned} & 8.54 \\ & 9.72 \\ & \hline \end{aligned}$ |
| 15 | Zebra | 465 | 37/4.00 | 465.00 | 28.00 | 1281 | 136.38 | 13907 | $\begin{aligned} & 350 \\ & 380 \\ & \hline \end{aligned}$ | $\begin{aligned} & 3477 \\ & 3477 \\ & \hline \end{aligned}$ | $\begin{aligned} & 4905 \\ & 4844 \end{aligned}$ | $\begin{array}{\|l} 4928 \\ 4869 \\ \hline \end{array}$ | $\begin{aligned} & 5013 \\ & 4964 \end{aligned}$ | $\begin{array}{l\|} \hline 6.69 \\ 7.77 \\ \hline \end{array}$ | $\begin{aligned} & 7.80 \\ & 8.94 \end{aligned}$ | $\begin{aligned} & 8.54 \\ & 9.72 \\ & \hline \end{aligned}$ |
| 16 | Zebra (UP) | 525 | 61/3.31 | 525.00 | 29.79 | 1448 | 146.03 | 14891 | $\begin{aligned} & 350 \\ & 380 \\ & \hline \end{aligned}$ | $\begin{array}{\|l\|} 3723 \\ 3723 \\ \hline \end{array}$ | $\begin{array}{\|l\|} \hline 5176 \\ 5106 \\ \hline \end{array}$ | $\begin{array}{\|l} 5200 \\ 5132 \\ \hline \end{array}$ | $\begin{aligned} & 5288 \\ & 5231 \\ & \hline \end{aligned}$ | $\begin{aligned} & 6.99 \\ & 8.12 \\ & \hline \end{aligned}$ | $\begin{aligned} & 8.08 \\ & 9.27 \\ & \hline \end{aligned}$ | $\begin{array}{r} 8.81 \\ 10.03 \\ \hline \end{array}$ |
| 17 | Moose | 570 | 61/3.45 | 570.20 | 31.05 | 1574 | 158.66 | 16179 | $\begin{aligned} & 380 \\ & 400 \\ & \hline \end{aligned}$ | $\begin{aligned} & 4045 \\ & 4045 \\ & \hline \end{aligned}$ | $\begin{array}{\|l\|} \hline 522 \\ 5472 \\ \hline \end{array}$ | $\begin{aligned} & 5549 \\ & 5501 \\ & \hline \end{aligned}$ | $\begin{array}{\|l\|} 5649 \\ 5608 \\ \hline \end{array}$ | $\begin{aligned} & \hline 8.13 \\ & 8.92 \\ & \hline \end{aligned}$ | $\begin{array}{\|r\|} 9.27 \\ 10.11 \\ \hline \end{array}$ | $\begin{array}{\|l\|} \hline 10.03 \\ 10.89 \\ \hline \end{array}$ |
| 18 | Morkulla | 605 | 61/3.55 | 603.80 | 31.95 | 1666 | 167.99 | 17130 | $\begin{aligned} & 380 \\ & 400 \\ & \hline \end{aligned}$ | $\begin{aligned} & 4283 \\ & 4283 \\ & \hline \end{aligned}$ | $\begin{aligned} & 5831 \\ & 5778 \\ & \hline \end{aligned}$ | $\begin{array}{\|l\|} 5858 \\ 5807 \\ \hline \end{array}$ | $\begin{aligned} & 5959 \\ & 5914 \\ & \hline \end{aligned}$ | $\begin{aligned} & 8.12 \\ & 8.92 \\ & \hline \end{aligned}$ | $\begin{array}{r} 9.27 \\ 10.11 \\ \hline \end{array}$ | $\begin{array}{\|l\|} \hline 10.03 \\ 10.89 \\ \hline \end{array}$ |
| 19 | Moose (up) Morkulla (up) | 640 | 61/3.66 | 641.80 | 32.94 | 1771 | 178.43 | 18195 | $\begin{aligned} & 380 \\ & 400 \\ & \hline \end{aligned}$ | $\begin{aligned} & 4549 \\ & 4549 \\ & \hline \end{aligned}$ | $\begin{array}{\|l\|} \hline 6175 \\ 6117 \\ \hline \end{array}$ | $\begin{array}{\|l} 6202 \\ 6146 \\ \hline \end{array}$ | $\begin{aligned} & 6304 \\ & 6255 \\ & \hline \end{aligned}$ | $\begin{aligned} & 8.13 \\ & 8.93 \\ & \hline \end{aligned}$ | $\begin{array}{\|r} 9.28 \\ 10.11 \\ \hline \end{array}$ | $\begin{array}{\|l\|} \hline 10.04 \\ 10.89 \\ \hline \end{array}$ |
| 20 | Morkulla (up) | 695 | 61/3.81 | 696.50 | 34.29 | 1919 | 193.25 | 19706 | $\begin{aligned} & 380 \\ & 400 \\ & \hline \end{aligned}$ | $\begin{aligned} & 4927 \\ & 4927 \\ & \hline \end{aligned}$ | $\begin{array}{\|l\|} \hline 6663 \\ 6598 \\ \hline \end{array}$ | $\begin{array}{\|l\|} \hline 6690 \\ 6628 \\ \hline \end{array}$ | $\begin{array}{\|l\|} \hline 6794 \\ 6738 \\ \hline \end{array}$ | $\begin{aligned} & \hline 8.13 \\ & 8.93 \\ & \hline \end{aligned}$ | $\begin{array}{\|r\|} \hline 9.28 \\ 10.11 \\ \hline \end{array}$ | $\begin{array}{\|l\|} \hline 10.04 \\ 10.90 \\ \hline \end{array}$ |
| 21 | Bersimis | 765 | 61/4.00 | 766.50 | 36.00 | 2116 | 213.01 | 21721 | $\begin{aligned} & 380 \\ & 400 \\ & \hline \end{aligned}$ | $\begin{aligned} & 5430 \\ & 5430 \\ & \hline \end{aligned}$ | $\begin{aligned} & 7314 \\ & 7241 \\ & \hline \end{aligned}$ | $\begin{aligned} & 7342 \\ & 7270 \\ & \hline \end{aligned}$ | $\begin{array}{l\|l\|} \hline 7447 \\ 7382 \\ \hline \end{array}$ | $\begin{aligned} & \hline 8.14 \\ & 8.94 \\ & \hline \end{aligned}$ | $\begin{array}{\|r\|} \hline 9.28 \\ 10.12 \\ \hline \end{array}$ | $\begin{aligned} & 10.04 \\ & 10.90 \\ & \hline \end{aligned}$ |

Rate: $E D T=25 \%$ of Rated Strength

## ALL ALUMINIUM ALLOY CONDUCTORS (AAAC) REC Spn. 33/1991/(R) \&

 Sizes for IS 398 (Part IV)/1994
## Electrical Parameters

| Sr. No. | EQVT. ACSR code | Nom Alloy Area | Stranding And Wire Diameter | DC Resistance <br> a) Standard <br> b) Maximum | AC Resistance at |  |  | Current Capacity |  |  |
| :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: |
|  |  |  |  |  | $65^{\circ} \mathrm{C}$ | $75^{\circ} \mathrm{C}$ | $90^{\circ} \mathrm{C}$ | $65^{\circ} \mathrm{C}$ | $75^{\circ} \mathrm{C}$ | $90^{\circ} \mathrm{C}$ |
|  |  | sq. mm | nos./mm | $\Omega / \mathrm{km}$ | $\Omega / \mathrm{km}$ | $\Omega / \mathrm{km}$ | $\Omega / \mathrm{km}$ | Amps | Amps | Amps |
| 1. | Mole | 15 | 3/2.50 | a) 2.2286 <br> b) 2.3040 | $\begin{aligned} & 2.5896 \\ & 2.6559 \\ & \hline \end{aligned}$ | $\begin{aligned} & 2.6699 \\ & 2.7381 \end{aligned}$ | $\begin{aligned} & 2.7902 \\ & 2.8616 \\ & \hline \end{aligned}$ | $\begin{aligned} & 33 \\ & 72 \\ & \hline \end{aligned}$ | $\begin{aligned} & 88 \\ & 87 \end{aligned}$ | $\begin{aligned} & 105 \\ & 104 \end{aligned}$ |
| 2. | Squirrel | 20 | 7/2.00 | a) 1.4969 <br> b) 1.5410 | $\begin{aligned} & 1.7395 \\ & 1.7912 \\ & \hline \end{aligned}$ | $\begin{aligned} & 1.7934 \\ & 1.8467 \\ & \hline \end{aligned}$ | $\begin{aligned} & 1.8742 \\ & 1.9299 \end{aligned}$ | $\begin{aligned} & 92 \\ & 90 \\ & \hline \end{aligned}$ | $\begin{aligned} & 110 \\ & 109 \\ & \hline \end{aligned}$ | $\begin{aligned} & 132 \\ & 130 \end{aligned}$ |
| 3. | Weasel | 34 | 7/2.50 | a) 0.9580 <br> b) 0.9900 | $\begin{aligned} & 1.1133 \\ & 1.1418 \end{aligned}$ | $\begin{aligned} & \hline 1.1478 \\ & 1.1772 \end{aligned}$ | $\begin{aligned} & 1.9950 \\ & 1.2302 \end{aligned}$ | $\begin{aligned} & 121 \\ & 119 \\ & \hline \end{aligned}$ | $\begin{aligned} & 146 \\ & 144 \end{aligned}$ | $\begin{aligned} & 175 \\ & 173 \\ & \hline \end{aligned}$ |
| 4. | Rabbit | 55 | 7/3.15 | a) 0.6034 <br> b) 0.6210 | $\begin{aligned} & 0.7013 \\ & 0.7215 \\ & \hline \end{aligned}$ | $\begin{aligned} & 0.7230 \\ & 0.7438 \\ & \hline \end{aligned}$ | $\begin{aligned} & 0.7556 \\ & 0.7773 \\ & \hline \end{aligned}$ | $\begin{aligned} & 160 \\ & 158 \\ & \hline \end{aligned}$ | $\begin{aligned} & 194 \\ & 191 \\ & \hline \end{aligned}$ | $\begin{aligned} & 234 \\ & 231 \\ & \hline \end{aligned}$ |
| 5. | Raccoon | 80 | 7/3.81 | a) 0.4125 <br> b) 0.4250 | $\begin{aligned} & 0.4795 \\ & 0.4942 \\ & \hline \end{aligned}$ | $\begin{aligned} & 0.4943 \\ & 0.5095 \\ & \hline \end{aligned}$ | $\begin{aligned} & 0.5166 \\ & 0.5325 \\ & \hline \end{aligned}$ | $\begin{aligned} & 202 \\ & 199 \\ & \hline \end{aligned}$ | $\begin{aligned} & 246 \\ & 242 \\ & \hline \end{aligned}$ | $\begin{aligned} & 297 \\ & 293 \\ & \hline \end{aligned}$ |
| 6. | Dog | 100 | 7/4.26 | a) 0.3299 <br> b) 0.3390 | $\begin{aligned} & 0.3836 \\ & 0.3945 \end{aligned}$ | $\begin{aligned} & 0.3955 \\ & 0.4067 \\ & \hline \end{aligned}$ | $\begin{aligned} & 0.4133 \\ & 0.4250 \\ & \hline \end{aligned}$ | $\begin{aligned} & 232 \\ & 229 \\ & \hline \end{aligned}$ | $\begin{aligned} & 283 \\ & 272 \\ & \hline \end{aligned}$ | $\begin{array}{r} 343 \\ 338 \\ \hline \end{array}$ |
| 7. | Dog(up) | 125 | 19/2.89 | a) 0.2654 <br> b) 0.2735 | $\begin{aligned} & 0.3087 \\ & 0.3181 \\ & \hline \end{aligned}$ | $\begin{aligned} & 0.3182 \\ & 0.3279 \\ & \hline \end{aligned}$ | $\begin{aligned} & 0.3325 \\ & 0.3427 \\ & \hline \end{aligned}$ | $\begin{aligned} & 266 \\ & 262 \\ & \hline \end{aligned}$ | $\begin{aligned} & 325 \\ & 320 \\ & \hline \end{aligned}$ | $\begin{array}{r} 394 \\ 389 \\ \hline \end{array}$ |
| 8. | Dog(up)/Coyote | 150 | 19/3.15 | a) 0.2234 <br> b) 0.2290 | $\begin{aligned} & 0.2599 \\ & 0.2674 \end{aligned}$ | $\begin{aligned} & 0.2680 \\ & 0.2756 \\ & \hline \end{aligned}$ | $\begin{aligned} & 0.2800 \\ & 0.2880 \\ & \hline \end{aligned}$ | $\begin{aligned} & 395 \\ & 291 \\ & \hline \end{aligned}$ | $\begin{aligned} & 362 \\ & 357 \\ & \hline \end{aligned}$ | $\begin{aligned} & 440 \\ & 434 \\ & \hline \end{aligned}$ |
| 9. | Wolf | 175 | 19/3,40 | a) 0.1918 <br> b) 0.1969 | $\begin{aligned} & 0.2232 \\ & 0.2293 \\ & \hline \end{aligned}$ | $\begin{aligned} & 0.2301 \\ & 0.2363 \\ & \hline \end{aligned}$ | $\begin{array}{l\|} \hline 0.2404 \\ 0.2470 \\ \hline \end{array}$ | $\begin{aligned} & 324 \\ & 320 \\ & \hline \end{aligned}$ | $\begin{aligned} & 398 \\ & 393 \\ & \hline \end{aligned}$ | $\begin{aligned} & 485 \\ & 478 \\ & \hline \end{aligned}$ |
| 10. | Wolf(up) | 200 | 19/3.66 | a) 0.1655 b) 0.1710 | $\begin{aligned} & 0.1927 \\ & 0.1988 \\ & \hline \end{aligned}$ | $\begin{aligned} & 0.1987 \\ & 0.2049 \\ & \hline \end{aligned}$ | $\begin{aligned} & 0.2076 \\ & 0.2141 \\ & \hline \end{aligned}$ | $\begin{aligned} & \hline 354 \\ & 349 \\ & \hline \end{aligned}$ | $\begin{aligned} & 436 \\ & 430 \\ & \hline \end{aligned}$ | $\begin{aligned} & 532 \\ & 524 \\ & \hline \end{aligned}$ |
| 11. | Panther | 232 | 19/3.94 | a) 0.1428 b) 0.1471 | $\begin{aligned} & 0.1664 \\ & 0.1714 \\ & \hline \end{aligned}$ | $\begin{aligned} & 0.1716 \\ & 0.1767 \\ & \hline \end{aligned}$ | $\begin{aligned} & 0.1792 \\ & 0.1846 \\ & \hline \end{aligned}$ | $\begin{array}{r} 387 \\ 382 \\ \hline \end{array}$ | $\begin{aligned} & 478 \\ & 471 \\ & \hline \end{aligned}$ | $\begin{aligned} & 584 \\ & 575 \\ & \hline \end{aligned}$ |
| 12. | Panther (up) | 290 | 37/3.15 | a) 0.11500 b) 0.11820 | $\begin{array}{\|l\|} \hline 0.13420 \\ 0.13800 \\ \hline \end{array}$ | $\begin{aligned} & 0.13830 \\ & 0.14230 \\ & \hline \end{aligned}$ | $\begin{aligned} & 0.14450 \\ & 0.14860 \\ & \hline \end{aligned}$ | $\begin{aligned} & 442 \\ & 436 \\ & \hline \end{aligned}$ | $\begin{aligned} & \hline 548 \\ & 540 \\ & \hline \end{aligned}$ | $\begin{aligned} & 670 \\ & 661 \\ & \hline \end{aligned}$ |
| 13. | Panther (up) | 345 | 37/3.45 | a) 0.09585 <br> b) 0.09840 | $\begin{array}{\|l\|} \hline 0.11211 \\ 0.11510 \\ \hline \end{array}$ | $\begin{aligned} & 0.11554 \\ & 0.11863 \\ & \hline \end{aligned}$ | $\begin{aligned} & 0.12069 \\ & 0.12391 \\ & \hline \end{aligned}$ | $\begin{array}{r} 493 \\ 487 \\ \hline \end{array}$ | $\begin{aligned} & 613 \\ & 605 \\ & \hline \end{aligned}$ | $\begin{aligned} & 752 \\ & 742 \\ & \hline \end{aligned}$ |
| 14. | Kundah | 400 | 37/3.71 | a) 0.08289 <br> b) 0.08550 | $\begin{array}{\|l\|} \hline 0.09717 \\ 0.10015 \\ \hline \end{array}$ | $\begin{aligned} & \hline 0.10013 \\ & 0.10320 \\ & \hline \end{aligned}$ | $\begin{aligned} & \hline 0.10457 \\ & 0.10779 \\ & \hline \end{aligned}$ | $\begin{aligned} & 538 \\ & 530 \\ & \hline \end{aligned}$ | $\begin{aligned} & \hline 670 \\ & 660 \\ & \hline \end{aligned}$ | $\begin{aligned} & 824 \\ & 811 \\ & \hline \end{aligned}$ |
| 15. | Zebra | 465 | 37/4.00 | a) 0.07130 <br> b) 0.07340 | $\begin{array}{\|l\|} \hline 0.08383 \\ 0.08627 \\ \hline \end{array}$ | $\begin{aligned} & \hline 0.08637 \\ & 0.08888 \\ & \hline \end{aligned}$ | $\begin{array}{l\|} \hline 0.09018 \\ 0.09281 \\ \hline \end{array}$ | $\begin{aligned} & \hline 589 \\ & 580 \\ & \hline \end{aligned}$ | $\begin{aligned} & \hline 736 \\ & 725 \\ & \hline \end{aligned}$ | $\begin{aligned} & 905 \\ & 892 \\ & \hline \end{aligned}$ |
| 16. | Zebra (up) | 525 | 61/3.31 | a) 0.06330 <br> b) 0.06510 | $\begin{array}{\|l\|} \hline 0.07466 \\ 0.07668 \\ \hline \end{array}$ | $\begin{aligned} & \hline 0.07691 \\ & 0.07899 \\ & \hline \end{aligned}$ | $\begin{aligned} & 0.08028 \\ & 0.08246 \\ & \hline \end{aligned}$ | $\begin{aligned} & 632 \\ & 623 \\ & \hline \end{aligned}$ | $\begin{aligned} & 792 \\ & 781 \\ & \hline \end{aligned}$ | $\begin{aligned} & 976 \\ & 963 \\ & \hline \end{aligned}$ |
| 17. | Moose | 570 | 61/3.45 | a) 0.05827 <br> b) 0.05980 | $\begin{aligned} & \hline 0.06891 \\ & 0.07070 \\ & \hline \end{aligned}$ | $\begin{aligned} & 0.07097 \\ & 0.07282 \\ & \hline \end{aligned}$ | $\begin{aligned} & \hline 0.07407 \\ & 0.07601 \\ & \hline \end{aligned}$ | $\begin{aligned} & 663 \\ & 655 \\ & \hline \end{aligned}$ | $\begin{aligned} & 833 \\ & 822 \\ & \hline \end{aligned}$ | $\begin{aligned} & 1028 \\ & 1015 \\ & \hline \end{aligned}$ |
| 18. | Morkulla | 605 | 61/3.55 | a) 0.05503 <br> b) 0.0580 | $\begin{array}{\|l\|} \hline 0.06521 \\ 0.06724 \\ \hline \end{array}$ | $\begin{aligned} & 0.06716 \\ & 0.06925 \\ & \hline \end{aligned}$ | $\begin{aligned} & 0.07008 \\ & 0.07227 \\ & \hline \end{aligned}$ | $\begin{aligned} & 686 \\ & 676 \\ & \hline \end{aligned}$ | $\begin{aligned} & 862 \\ & 849 \\ & \hline \end{aligned}$ | $\begin{array}{r} 1065 \\ 1049 \\ \hline \end{array}$ |
| 19. | Moose(up) | 640 | 61/3.66 | a) 0.05177 <br> b) 0.05340 | $\begin{array}{\|l\|} \hline 0.06150 \\ 0.06337 \\ \hline \end{array}$ | $\begin{aligned} & 0.06332 \\ & 0.06525 \\ & \hline \end{aligned}$ | $\begin{aligned} & 0.06607 \\ & 0.06808 \\ & \hline \end{aligned}$ | $\begin{aligned} & \hline 711 \\ & 700 \\ & \hline \end{aligned}$ | $\begin{aligned} & 894 \\ & 881 \\ & \hline \end{aligned}$ | $\begin{aligned} & 1106 \\ & 1089 \\ & \hline \end{aligned}$ |
| 20. | Morkulla (up) | 695 | 61/3.81 | a) 0.04778 <br> b) 0.04920 | $\begin{array}{\|l\|} \hline 0.05697 \\ 0.05864 \\ \hline \end{array}$ | $\begin{aligned} & 0.05865 \\ & 0.06037 \end{aligned}$ | $\begin{aligned} & 0.06117 \\ & 0.06297 \end{aligned}$ | $\begin{aligned} & 745 \\ & 734 \end{aligned}$ | $\begin{aligned} & 939 \\ & 925 \\ & \hline \end{aligned}$ | $\begin{aligned} & 1162 \\ & 1145 \end{aligned}$ |
| 21. | Bersimis | 765 | 61/4.00 | a) 0,04335 <br> b) 0.04460 | $\begin{array}{\|l\|} \hline 0.05196 \\ 0.05341 \\ \hline \end{array}$ | $\begin{aligned} & 0.05348 \\ & 0.05497 \end{aligned}$ | $\begin{aligned} & 0.05576 \\ & 0.05732 \end{aligned}$ | $\begin{aligned} & 788 \\ & 777 \end{aligned}$ | $\begin{aligned} & 995 \\ & 981 \end{aligned}$ | $\begin{aligned} & 1234 \\ & 1217 \end{aligned}$ |

Note:
Resistance
(a) At resistivity $0.0325 \Omega-\mathrm{m} \mathrm{m}^{7} / \mathrm{mm}$ and nominal diameter of wires
(b) At resistivity $0.0325 \Omega-\mathrm{mm}^{2} / \mathrm{mm}$ and minimum diameter of wires

ALL ALUMINIUM ALLOY CONDUCTORS (AAAC) REC Spn-No. 33/1984 (R-1991)

Distribution Conductors to REC Standards

| AAAC Size to <br> Size <br> equivalent to <br> ACSR <br> Code | Nominal <br> Alu-Area | Stranding <br> And Wire <br> Diameter | Sectional <br> Area | Approx. <br> Overall <br> Diameter | Approx. <br> Mass | Calculated <br> Resistance <br> at 20 | Approx. <br> (Maximum) |
| :--- | ---: | ---: | ---: | ---: | ---: | ---: | ---: |
| Calculated <br> Breaking <br> Load |  |  |  |  |  |  |  |
| Mole | $\mathrm{mm}^{2}$ | mm | $\mathrm{~mm}^{2}$ | mm | $\mathrm{~kg} / \mathrm{km}$ | $\Omega / \mathrm{km}$ | kN |
| Squirrel | 14 | $3 / 2.50$ | 14.73 | 5.38 | 40.13 | 2.304 | 4.331 |
| Weasel | 20 | $7 / 2.00$ | 21.99 | 6.00 | 60.13 | 1.541 | 6.467 |
| Rabbit | 30 | $7 / 2.50$ | 34.36 | 7.50 | 94.00 | 0.990 | 10.106 |
| Raccoon | 50 | $7 / 3.15$ | 54.55 | 9.45 | 149.20 | 0.621 | 16.044 |
| Dog | 80 | $7 / 3.81$ | 79.81 | 11.43 | 218.26 | 0.425 | 23.473 |

ALUMINIUM ALLOY WIRES USED IN THE CONSTRUCTION OF STRANDED ALUMINIUM ALLOY CONDUCTORS as per IS - 398 Part IV/1994

| Diameter |  |  | Cross Sectional Area of Nominal Diameter of Wire | Mass | Minimum Breaking Load |  | Resistance at $20^{\circ} \mathrm{C}$ Maximum |
| :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: |
| Nom. | Min. | Max. |  |  | Before Stranding | After Stranding |  |
| mm | mm | mm | $\mathrm{mm}^{2}$ | kg/km | kN | kN | $\Omega / \mathrm{km}$ |
| (1) | (2) | (3) | (4) | (5) | (6) | (7) | (8) |
| 2.00 | 1.98 | 2.02 | 3.142 | 8.482 | 0.97 | 0.92 | 10.653 |
| 2.50 | 2.47 | 2.53 | 4.909 | 13.25 | 1.52 | 1.44 | 6.845 |
| 2.89 | 2.86 | 2.92 | 6.560 | 17.71 | 2.03 | 1.93 | 5.106 |
| 3.15 | 3.12 | 3.18 | 7.793 | 21.04 | 2.41 | 2.29 | 4.290 |
| 3.31 | 3.28 | 3.34 | 8.605 | 23.23 | 2.66 | 2.53 | 3.882 |
| 3.40 | 3.37 | 3.43 | 9.079 | 24.51 | 2.80 | 2.66 | 3.677 |
| 3.45 | 3.42 | 3.48 | 9.348 | 25.24 | 2.89 | 2.75 | 3.571 |
| 3.55 | 3.51 | 3.59 | 9.998 | 26.72 | 3.60 | 2.91 | 3.390 |
| 3.66 | 3.62 | 3.70 | 10.52 | 26.41 | 3.25 | 3.09 | 3.187 |
| 3.71 | 3.67 | 3.75 | 10.81 | 21.19 | 3.34 | 3.17 | 3.101 |
| 3.81 | 3.77 | 3.85 | 11.40 | 30.78 | 3.52 | 3.34 | 2.938 |
| 3.94 | 3.90 | 3.98 | 12.19 | 32.92 | 3.77 | 3.58 | 2.746 |
| 4.00 | 3.96 | 4.04 | 12.57 | 33.93 | 3.88 | 3.69 | 2.663 |
| 4.26 | 4.22 | 4.30 | 14.25 | 38.48 | 4.40 | 4.18 | 2.345 |

## ALUMINIUM CONDUCTORS STEEL REINFORCED (ACSR) Sizes to IS 398 (Part II) / 1976

## Mechanical Parameters

| Sr. | $\begin{aligned} & \text { ACSR } \\ & \text { Code } \end{aligned}$ | $\begin{array}{\|l\|} \hline \text { Nom: } \\ \text { Alum } \\ \text { Area } \end{array}$ | Stranding and Wire Diameter Alm + Steel | Sectional Area |  | Approximate |  | Rated Strength |  | Span | Tension |  |  |  | Sag |  |  |
| :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: |
| No. |  |  |  | Alum | Total | OD | Mass |  |  | $32^{\circ} \mathrm{C}$ | $0^{\circ} \mathrm{C}$ |  |  | $53^{\circ} \mathrm{C}$ | $75^{\circ} \mathrm{C}$ | $90^{\circ} \mathrm{C}$ |
|  |  | sq m | Nos./mm | sq mm | sq mm | mm | kg/k | kN | Kgf |  | m | Kgf | Kgf | Kgf | Kgf | m | m | m |
|  |  |  |  |  |  |  |  |  |  |  |  | $\begin{aligned} & \text { Wind pressure } \\ & \text { kg/sq. } \mathrm{m} \\ & 50 \quad 75 \quad 100 \\ & \hline \end{aligned}$ |  |  |  |  |  |
| 1 | Mole | 10 | $6+1 / 1.50$ | 10.60 | 12.37 | 4.50 | 43 | 3.97 | 405 | 67 | 101 | 174 | 187 | 201 | NA | 0.62 | NA |
| 2 | Squirrel | 20 | $6+1 / 2.11$ | 20.98 | 24.48 | 6.33 | 85 | 7.61 | 776 | 67 | 194 | 325 | 341 | 370 | NA | 0.65 | NA |
|  |  |  |  |  |  |  |  |  |  | 107 | 194 | 339 | 360 | 404 | NA | 1.31 | NA |
| 3 | Weasel | 30 | $6+1 / 2.59$ | 31.61 | 36.88 | 7.77 | 128 | 11.12 | 1134 | 67 | 284 | 475 | 493 | 514 | NA | 0.67 | NA |
|  |  |  |  |  |  |  |  |  |  | 107 | 284 | 487 | 523 | 564 | NA | 1.34 | NA |
| 4 | Rabbit | 50 | $6+1 / 3.35$ | 52.88 | 61.70 | 10.05 | 214 | 18.25 | 1861 | 67 | 465 | 774 | 793 | 818 | NA | 0.68 | NA |
|  |  |  |  |  |  |  |  |  |  | 107 | 465 | 780 | 823 | 873 | NA | 1.37 | NA |
|  |  |  |  |  |  |  |  |  |  | 125 | 465 | 784 | 838 | 899 | NA | 1.73 | NA |
| 5 | Raccoon | 80 | 6+1/4.09 | 78.83 | 91.97 | 12.27 | 319 | 26.91 | 2744 | 125 | 686 | 1135 | 1196 | 1267 | NA | 1.74 | NA |
| 6 | Dog | 100 | $6 / 4.72$ $+7 / 1.57$ | 105.00 | 118.50 | 14.15 | 394 | 32.41 | 3305 | 125 | 826 | 1389 | 1457 | 1537 | NA | 1.81 | NA |
|  |  |  |  |  |  |  |  |  |  |  |  | Wind pressure $\mathrm{kg} / \mathrm{sq} . \mathrm{m}$ <br> $43 \quad 45 \quad 52$ |  |  |  |  |  |
| 7 | Leopard | 130 | 6/5.28 | 131.40 | 148.20 | 15.81 | 492 | 40.70 | 4150 | 240 | 1034 | 1612 | 1625 | 1672 | 4.16 | 4.92 | NA |
|  |  |  | +7/1.75 |  |  |  |  |  |  | 260 | 1034 | 1597 | 1611 | 1664 | 4.80 | 5.60 | NA |
| 8 | Coyote | 130 | 26/2.54 | 131.70 | 152.20 | 15.89 | 522 | 46.40 | 4739 | 260 | 1183 | 1782 | 1795 | 1845 | 4.47 | 5.25 | NA |
|  |  |  | +7/1.91 |  |  |  |  |  |  | 275 | 1183 | 1771 | 1786 | 1839 | 4.94 | 5.75 | NA |
| 9 | Wolf | 150 | $30+7 / 2.5$ | 158.10 | 194.90 | 18.13 | 726 | 67.34 | 6867 | 260 | 1717 | 2428 | 2441 | 2489 | 4.24 | 4.95 | NA |
|  |  |  |  |  |  |  |  |  |  | 275 | 1717 | 2413 | 2427 | 2479 | 4.69 | 5.44 | NA |
| 10 | Lynx | 180 | $30+7 / 2.79$ | 183.40 | 226.20 | 19.53 | 844 | 77.96 | 7950 | 300 | 1998 | 2739 | 2755 | 2815 | 5.52 | 6.31 | NA |
| 11 | Panther | 200 | $30+7 / 3.00$ | 212.10 | 261.50 | 21.00 | 974 | 89.67 | 9144 | 320 | 2286 | 3095 | 3113 | 3180 | 6.24 | 7.06 | NA |
| 12 | Goat | 320 | $30+7 / 3.71$ | 324.30 | 400.00 | 25.97 | 1488 | 137.00 | 13975 | 320 | 3494 | 4628 | 4647 | 4719 | 6.24 | 7.05 | NA |
|  |  |  |  |  |  |  |  |  |  | 350 | 3494 | 4555 | 4576 | 4656 | 7.36 | 8.22 | NA |
| 13 | Drake | 400 | 26/4.44 | 402.60 | 468.00 | 28.11 | 1628 | 139.00 | 14175 | 350 | 3544 | 4679 | 4703 | 4794 | 7.93 | 8.44 | NA |
|  |  |  | +7/1.96 |  |  |  |  |  |  | 380 | 2264 | 3021 | 3049 | 3156 | 11.20 | 12.17 | NA |
| 14 | Kundah | 400 | 42/3.5 | 404.10 | 425.20 | 26.88 | 1281 | 88.80 | 9054 | 350 | 2264 | 3082 | 3110 | 3212 | 9.62 | 10.57 | NA |
|  |  |  | +7/1.96 |  |  |  |  |  |  | 380 | 2264 | 3021 | 3049 | 3156 | 11.20 | 12.17 | NA |
| 15 | Zebra | 420 | $54+7 / 3.18$ | 428.90 | 484.50 | 28.62 | 1621 | 130.30 | 13289 | 350 | 3322 | 4338 | 4362 | 4454 | 8.35 | 9.24 | NA |
|  |  |  |  |  |  |  |  |  |  | 380 | 3322 | 4265 | 4292 | 4390 | 9.72 | 10.65 | NA |
| 16 | Deer | 420 | $30+7 / 4.27$ | 429.60 | 529,80 | 29.89 | 1979 | 178.40 | 18190 | 350 | 4548 | 5841 | 4863 | 5863 | 8.73 | 9.63 | NA |
|  |  |  |  |  |  |  |  |  |  | 380 | 4548 | 5748 | 5772 | 5863 | 8.73 | 9.63 | NA |
| 17 | Moose | 520 | $54+7 / 3.53$ | 528.50 | 597.00 | 31.77 | 1998 | 159.60 | 16275 | 380 | 4069 | 5155 | 5182 | 5283 | 9.78 | 10.70 | NA |
|  |  |  |  |  |  |  |  |  |  | 400 | 4069 | 5101 | 5129 | 5234 | 10.76 | 11.70 | NA |
| 18 | Morkulla | 560 | 42/4.13 | 562.70 | 591.70 | 31.68 | 1781 | 120.20 | 12253 | 380 | 3063 | 3947 | 3977 | 4089 | 11.37 | 12.43 | NA |
|  |  |  | +7/2.30 |  |  |  |  |  |  | 400 | 3063 | 3899 | 3929 | 4044 | 12.52 | 13.59 | NA |
| 19 | Bersimis | 690 | 42/4.57 | 688.90 | 724.40 | 35.04 | 2187 | 146.90 | 14977 | 400 | 3744 | 4686 | 4717 | 4834 | 12.66 | 13.64 | NA |
|  |  |  | +7/2.54 |  |  |  |  |  |  |  |  |  |  |  |  |  |  |

## DICABS

## ALUMINIUM CONDUCTORS STEEL REINFORCED (ACSR) Sizes to IS 398 (Part II) / 1976

Electrical Parameters

| Sr . <br> No. | ACSR Code | Nom. Alum. Area | Stranding and Wire Diameter Alm. + Steel | DCResistanceat $20^{\circ} \mathrm{C}$ | AC Resistance at in $\Omega / \mathrm{km}$ |  |  | Current Capacity in amperes |  |  |
| :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: |
|  |  |  |  |  | $65^{\circ} \mathrm{C}$ | $75^{\circ} \mathrm{C}$ | $90^{\circ} \mathrm{C}$ | $65^{\circ} \mathrm{C}$ | $75^{\circ} \mathrm{C}$ | $90^{\circ} \mathrm{C}$ |
|  |  | sq. mm | Nos./ <br> mm | $\Omega / \mathrm{km}$ | $\Omega / \mathrm{km}$ | $\Omega / \mathrm{km}$ | $\Omega / \mathrm{km}$ | amps | amps | amps |
| 1. | Mole | 10 | $6+1 / 1.50$ | 2.78 | 3.777 | 3.905 | NA | 58 | 70 | NA |
| 2. | Squirrel | 20 | $6+1 / 2.11$ | 1.394 | 1.894 | 1.958 | NA | 89 | 107 | NA |
| 3. | Weasel | 30 | $6+1 / 2.59$ | 0.9291 | 1.262 | 1.305 | NA | 114 | 138 | NA |
| 4. | Rabbit | 50 | $6+1 / 3.35$ | 0.5524 | 0.7506 | 0.7761 | NA | 157 | 190 | NA |
| 5. | Raccoon | 80 | $6+1 / 4.09$ | 0.3712 | 0.5044 | 0.5216 | NA | 200 | 244 | NA |
| 6. | Dog | 100 | 6/4.72 | 0.2792 | 0.3794 | 0.3924 | NA | 239 | 291 | NA |
|  |  |  | +7/1.57 |  |  |  |  |  |  |  |
| 7. | Leopard | 130 | 6/5.28 | 0.2226 | 0.3026 | 0.3129 | NA | 274 | 335 | NA |
|  |  |  | +7/1.75 |  |  |  |  |  |  |  |
| 8. | Coyote | 130 | 26/2.54 | 0.2246 | 0.2663 | 0.2754 | NA | 292 | 358 | NA |
|  |  |  | +7/1.91 |  |  |  |  |  |  |  |
| 9. | Wolf | 150 | $30+7 / 2.59$ | 0.1871 | 0.2219 | 0.2295 | NA | 329 | 405 | NA |
| 10. | Lynx | 180 | $30+7 / 2.79$ | 0.161 | 0.1909 | 0.1974 | NA | 361 | 445 | NA |
| 11. | Panther | 200 | $30+7 / 3.00$ | 0.139 | 0.165 | 0.1706 | NA | 395 | 487 | NA |
| 12. | Goat | 320 | $30+7 / 3.71$ | 0.09106 | 0.1082 | 0.1119 | NA | 510 | 634 | NA |
| 13. | Drake | 400 | 26/4.44 | 0.07309 | 0.08709 | 0.09003 | NA | 578 | 721 | NA |
|  |  |  | +3.45 |  |  |  |  |  |  |  |
| 14. | Kundah | 400 | 42/3.5 | 0.07269 | 0.08917 | 0.09217 | NA | 566 | 705 | NA |
|  |  |  | +7/1.96 |  |  |  |  |  |  |  |
| 15. | Zebra | 420 | $54+7 / 3.18$ | 0.06869 | 0.08416 | 0.08699 | NA | 590 | 737 | NA |
| 16. | Deer | 420 | $30+7 / 4.27$ | 0.06854 | 0.08164 | 0.0844 | NA | 605 | 756 | NA |
| 17. | Moose | 520 | $54+7 / 3.53$ | 0.05596 | 0.06881 | 0.07111 | NA | 667 | 836 | NA |
| 18. | Morkulla | 560 | 42/4.13 | 0.05232 | 0.06467 | 0.06681 | NA | 688 | 862 | NA |
|  |  |  | +7/2.30 |  |  |  |  |  |  |  |
| 19. | Bersimis | 690 | 42/4.57 | 0.04242 | 0.05092 | 0.0524 | NA | 791 | 998 | NA |
|  |  |  | +7/2.54 |  |  |  |  |  |  |  |

[^1]ALL ALUMINIUM CONDUCTORS (TO IS 398)

| No. And <br> Diameter of <br> wires | Nominal Copper Area | Calculated Eq: area of Aluminium | Approx. Overall diameter | Approx. Wt. | $\begin{gathered} \text { Resistance At } \\ 20^{\circ} \mathrm{C} \end{gathered}$ | Ultimate Strength of Condr. |
| :---: | :---: | :---: | :---: | :---: | :---: | :---: |
| mm | $\mathrm{mm}^{2}$ | $\mathrm{mm}^{2}$ | mm | $\mathrm{Kg} . / \mathrm{Km}$ | $\Omega / \mathrm{Km}$. | Kg . |
| 7/1.50 | 7.5 | 12.23 | 4.50 | 34 | 2.32600 | 220 |
| 7/1.96 | 13.0 | 20.89 | 5.88 | 58 | 1.36200 | 385 |
| 7/2.21 | 16.0 | 26.56 | 6.63 | 73 | 1.07100 | 485 |
| 7/2.44 | 20.0 | 32.37 | 7.32 | 89 | 0.87870 | 580 |
| 7/2.79 | 25.0 | 42.33 | 8.37 | 117 | 0.67210 | 737 |
| 7/3.10 | 30.0 | 52.26 | 9.30 | 144 | 0.54440 | 892 |
| 7/3.40 | 40.0 | 62.86 | 10.20 | 174 | 0.45260 | 1051 |
| 7/3.66 | 45.0 | 72.84 | 10.95 | 201 | 0.39060 | 1203 |
| 7/3.78 | 48.0 | 77.70 | 11.34 | 215 | 0.36620 | 1272 |
| 7/3.91 | 50.0 | 83.13 | 11.73 | 230 | 0.34220 | 1356 |
| 7/4.17 | 60.0 | 94.56 | 12.51 | 261 | 0.30090 | 1523 |
| 7/4.39 | 65.0 | 104.80 | 13.17 | 290 | 0.27150 | 1673 |
| 19/3.00 | 80.0 | 132.20 | 15.00 | 369 | 0.21520 | 2228 |
| 19/3.18 | 90.0 | 148.50 | 15.90 | 414 | 0.19160 | 2484 |
| 19/3.53 | 110.0 | 183.00 | 17.65 | 511 | 0.15550 | 2985 |
| 19/3.78 | 130.0 | 209.90 | 18.90 | 586 | 0.13560 | 3381 |
| 19/3.99 | 140.0 | 233.80 | 19.95 | 652 | 0.12170 | 3736 |
| 19/4.22 | 160.0 | 261.50 | 21.10 | 730 | 0.10880 | 4144 |
| 19/4.65 | 185.0 | 317.50 | 23.25 | 886 | 0.08959 | 4947 |
| 19/5.00 | 225.0 | 367.20 | 25.00 | 1025 | 0.07749 | 5695 |
| 19/5.36 | 260.0 | 421.90 | 26.80 | 1176 | 0.06743 | 6516 |
| 37/4.09 | 300.0 | 473.60 | 28.63 | 1343 | 0.05982 | 7289 |
| 37/4.27 | 325.0 | 518.50 | 29.89 | 1464 | 0.05488 | 7878 |

## STRANDED STEEL-CORED ALUMINIUM CONDUCTORS (TO IS: 398)

| No. and Diameter of wires |  | Nominal Copper Area $\mathrm{mm}^{2}$ | Calculated Eq: area of Alu. $\mathrm{mm}^{2}$ | Approx. overall diameter mm | Approx. Wt. in Kg./Km |  |  | $\begin{gathered} \text { Resistance } \\ \text { at } 20^{\circ} \mathrm{C} \\ \Omega / \mathrm{Km} \end{gathered}$ | Ultimate strength Kg . |
| :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: |
| Alu. mm. | Steel mm. |  |  |  | Alu. Kg. | Steel Kg . | Complete conductor Kg . |  |  |
| 6/1.50 | 1/1.50 | 6.5 | 10.47 | 4.50 | 29.0 | 14.0 | 43 | 2.71800 | 407 |
| 6/2.11 | 1/2.11 | 13 | 20.71 | 6.33 | 58 | 27 | 85 | 1.37400 | 771 |
| 6/2.36 | 1/2.36 | 16 | 25.11 | 7.08 | 72 | 34 | 106 | 1.09800 | 952 |
| 6/2.59 | 1/2.59 | 20 | 31.21 | 7.77 | 87 | 41 | 128 | 0.91160 | 1137 |
| 6/3.00 | 1/3.00 | 25 | 41.87 | 9.00 | 116 | 55.0 | 171 | 0.67950 | 1503 |
| 6/3.35 | 1/3.35 | 30 | 52.21 | 10.05 | 145.0 | 69.0 | 214 | 0.54490 | 1860 |
| 6/3.66 | 1/3.66 | 40 | 62.32 | 10.98 | 173 | 82 | 255 | 0.45650 | 2207 |
| 12/2.79 | 7/2.79 | 42 | 71.58 | 13.95 | 199 | 334 | 533 | 0.39770 | 6108 |
| 6/3.99 | 1/3.99 | 45 | 74.07 | 11.97 | 203 | 98 | 301 | 0.38410 | 2613 |
| 6/4.09 | 1/4.09 | 48 | 77.83 | 12.27 | 215 | 104 | 319 | 0.36560 | 2746 |
| 6/4.22 | 1/4.22 | 50 | 82.85 | 12.66 | 227 | 109 | 336 | 0.34340 | 2983 |
| 6/4.50 | 1/4.50 | 55 | 94.21 | 13.50 | 258 | 124.0 | 382 | 0.30200 | 3324 |
| 6/4.72 | 7/1.57 | 65 | 103.60 | 14.16 | 287 | 107 | 394 | 0.27450 | 3299 |
| 6/5.28 | 7/1.76 | 80 | 129.70 | 15.81 | 356 | 136 | 492 | 0.21930 | 4137 |
| 26/2.54 | 7/1.90 | 80 | 128.50 | 15.89 | 357 | 165 | 522 | 0.22140 | 4638 |
| 30/2.36 | 7/2.36 | 80 | 128.10 | 16.52 | 363.5 | 240.5 | 604 | 0.22210 | 5758 |
| 30/2.59 | 7/2.59 | 95 | 154.30 | 18.13 | 428 | 298 | 726 | 0.18440 | 6880 |
| 30/2.79 | 7/2.79 | 110 | 179.00 | 19.53 | 497 | 347 | 844 | 0.15890 | 7950 |
| 30/3.00 | 7/3.00 | 130 | 207.00 | 21.00 | 587 | 387 | 974 | 0.13750 | 9127 |
| 30/3.18 | 7/3.18 | 140 | 232.50 | 22.26 | 657 | 443 | 1100 | 0.12230 | 10210 |
| 30/3.35 | 7/3.35 | 160 | 258.10 | 23.45 | 651 | 492 | 1143 | 0.11020 | 11310 |
| 30/3.71 | 7/3.71 | 185 | 316.50 | 25.97 | 878 | 610 | 1488 | 0.08989 | 13780 |
| 30/3.99 | 7/3.99 | 225 | 366.10 | 27.93 | 1035 | 691 | 1726 | 0.07771 | 15910 |
| 42/3.50 | 7/1.96 | 250 | 394.40 | 26.82 | 1114 | 168 | 1282 | 0.07434 | 9002 |
| 30/4.27 | 7/4.27 | 260 | 419.30 | 29.89 | 1163 | 816 | 1979 | 0.06786 | 18230 |
| 30/4.50 | 7/4.50 | 300 | 465.70 | 31.50 | 1317 | 887 | 2196 | 0.06110 | 20240 |
| 54/3.35 | 7/3.55 | 300 | 464.50 | 30.15 | 1314 | 492 | 1804 | 0.06125 | 14750 |
| 54/3.535 | 7/3.53 | 325 | 515.70 | 31.77 | 1466 | 536 | 2002 | 0.05517 | 16250 |

ALUMINIUM WIRES USED IN THE CONSTRUCTION OF ALUMINIUM CONDUCTORS, GALVANIZED STEEL-REINFORCED
(Clauses 6.1,8.1.1, 13.2, 13.3.1, 13.5.1 and 13.6) (IS : (Part II) 1996)

| Diameter |  |  | Cross Sectional Area of Nominal Diameter Wire | Mass | $\begin{aligned} & \text { Resistance } \\ & 20^{\circ} \mathrm{C} \end{aligned}$ | Breaking Load (Min) |  |
| :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: |
| Nominal | Min | Max |  |  |  | Before Stranding | After Stranding |
| 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 |
| mm | mm | mm | $\mathrm{mm}^{2}$ | kg/km | Ohm/km | kN | kN |
| 1.50 | 1.48 | 1.52 | 1.767 | 4.78 | 16.432 | 0.32 | 0.30 |
| 1.96 | 1.94 | 1.98 | 3.017 | 8.16 | 9.561 | 0.54 | 0.51 |
| 2.11 | 2.09 | 2.13 | 3.497 | 9.45 | 8.237 | 0.63 | 0.60 |
| 2.59 | 2.56 | 2.62 | 5.269 | 14.24 | 5.490 | 0.89 | 0.85 |
| 3.00 | 2.97 | 3.03 | 7.069 | 19.11 | 4.079 | 1.17 | 1.11 |
| 3.18 | 3.15 | 3.21 | 7.942 | 21.47 | 3.626 | 1.29 | 1.23 |
| 3.35 | 3.32 | 3.38 | 8.814 | 23.82 | 3.265 | 1.43 | 1.36 |
| 3.50 | 3.46 | 3.54 | 9.621 | 26.01 | 3.006 | 1.55 | 1.47 |
| 3.53 | 3.49 | 3.57 | 9.787 | 26.45 | 2.954 | 1.57 | 1.49 |
| 3.80 | 3.76 | 3.84 | 11.34 | 30.65 | 2.545 | 1.80 | 1.71 |
| 4.09 | 4.05 | 4.13 | 13.14 | 35.51 | 2.194 | 2.08 | 1.98 |
| 4.13 | 4.09 | 4.17 | 13.40 | 36.21 | 2.151 | 2.13 | 2.02 |
| 4.72 | 4.67 | 4.77 | 17.50 | 47.30 | 1.650 | 2.78 | 2.64 |

Note: 1 . The resistance has been calculated from the maximum value of restivity and the cross section based on the minimum diameter.

STEEL WIRES USED IN THE CONSTRUCTION OF ALUMINIUM CONDUCTORS,

| Diameter |  |  | Cross Sectional Area of Nominal Diameter Wire | Mass | Breaking Load (Min) |  |
| :---: | :---: | :---: | :---: | :---: | :---: | :---: |
| Nominal | Min | Max |  |  | Before Stranding | After Stranding |
| 1 | 2 | 3 | 4 | 5 | 6 | 7 |
| mm | mm | mm | $\mathrm{mm}^{2}$ | kg/km | kN | KN |
| 1.50 | 1.47 | 1.53 | 1.767 | 13.78 | 2.46 | 2.34 |
| 1.57 | 1.54 | 1.60 | 1.936 | 15.10 | 2.70 | 2.57 |
| 1.96 | 1.92 | 2.00 | 3.017 | 23.53 | 4.20 | 3.99 |
| 2.11 | 2.07 | 2.15 | 3.497 | 27.27 | 4.60 | 4.37 |
| 2.30 | 2.25 | 2.35 | 4.155 | 32.41 | 5.46 | 5.19 |
| 2.59 | 2.54 | 2.64 | 5.269 | 41.09 | 6.92 | 6.57 |
| 3.00 | 2.94 | 3.06 | 7.069 | 55.13 | 9.29 | 8.83 |
| 3.18 | 3.12 | 3.24 | 7.942 | 61.95 | 10.43 | 9.91 |
| 3.35 | 3.28 | 3.42 | 8.814 | 68.75 | 11.58 | 11.00 |
| 3.53 | 3.46 | 3.60 | 9.787 | 76.34 | 12.86 | 12.22 |
| 4.09 | 4.01 | 4.17 | 13.14 | 102.48 | 17.27 | 16.41 |

## ALUMINIUM CONDUCTORS, GALVANIZED STEEL-REINFORCED

IS 398 (Part - 2) 1996

| Nominal <br> Aluminium | Stranding and Wire <br> Diameter | Sectional <br> Area of <br> Aluminium | Total <br> Sectional <br> Area | Approximate <br> Diameter | Approximate <br> Mass | Calculated <br> Resistance <br> at20 ${ }^{\circ} \mathrm{C}$ <br> (Max) | Approximate <br> Calculated |
| :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: |
|  |  |  |  |  |  |  |  |$|$

Note : For the basis at calculation at this table (see appendix A) The Sectional area is the sum of the cross - sectional area of the relevant individual wires.

TABLE 4. LAY RATIO OF ALUMINIUM CONDUCTORS, GALVANIZED STEEL-REINFORCED

| 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 11 |
| :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: |
| Number of wires |  | Rate of Alu. Wire Diameter to Steel Wire Diameter | Lay Ratio for Steel Core ( 6 wire Layer) |  | Lay Ratios for Aluminium Wire |  |  |  |  |  |
| Alu | Steel |  |  |  | Outer | Layer | Layer I Beneat | ediately utermost r | Innerm Cond ALU. | ayer of with 3 <br> Layer |
|  |  |  | Min | Max | Min | Max | Min | Max | Min | Max |
| 6 | 1 | 1.0 | . | - | 10 | 14 | . | . | . | . |
| 6 | 7 | 3.0 | 13 | 28 | 10 | 14 | - | - | - | . |
| 30 | 7 | 1.0 | 13 | 28 | 10 | 14 | 10 | 16 | $\cdot$ | - |
| 42 | 7 | 1.8 | 13 | 28 | 10 | 14 | 10 | 16 | 10 | 17 |
| 54 | 7 | 1.0 | 13 | 28 | 10 | 14 | 10 | 16 | 10 | 17 |

Note: For the purpose of calculation, the mean lay ratio shall be taken as the arithmetic mean
of the relevant minimum and maximum values given in this table.

## Standing Constants

| Number of wires in <br> conductor |  | Mass |  | Stranding Constant <br> Electrical Resistance |
| :---: | :---: | :---: | :---: | :---: |
| Aluminium | Steel | Aluminium | Steel |  |
| 1 | 2 | 3 | 4 | 0.1692 |
| 6 | 1 | 6.091 | 1.000 | 0.1692 |
| 6 | 7 | 6.091 | 7.032 | 0.03408 |
| 30 | 7 | 30.67 | 7.032 | 0.02432 |
| 42 | 7 | 42.90 | 7.032 | 0.01894 |
| 54 | 7 | 55.23 | 7.032 |  |

## MODULUS OF ELASTICITY AND COEFFICIENT OF LINEAR EXPANSION

| Number of wires |  | Final Modulus of Elasticity <br> (Practical) GN/m | Coefficient of <br> Linear Expansion <br> / |
| :---: | :---: | :---: | :---: |
| Aluminium | Steel |  | 4 |
| 1 | 2 | 79 | $19.1 \times 10^{-6}$ |
| 6 | 1 | 75 | $19.8 \times 10^{-6}$ |
| 6 | 7 | 80 | $17.8 \times 10^{-6}$ |
| 30 | 7 | 62 | $21.5 \times 10^{-6}$ |
| 42 | 7 | 69 | $19.3 \times 10^{6}$ |
| 54 | 7 |  |  |

Notes.

1. These values are given for information only.
2. Moduli values quoted may be regarded as being accurate to within $\pm \mathrm{GN} / \mathrm{m}^{2}$.
3. Moduli values quoted may be taken as applying to conductors stressed between 15 and 50 percent of the ultimate strength of the conductor.
4. Coefficients of linear expansions have been calculated from the final (Practical) moduli for the aluminium and steel components of the conductors and coefficients of linear expansion of $23 \times 10^{-6}$ and $11.5 \times 10^{-6} /^{\circ} \mathrm{C}$ for aluminium and steel respectively.

WEIGHT OF ALUMINIUM, STEEL AND TOTAL WEIGHT IN KG/KM FOR ACSR CONFIRMING TO IS 398(P-II) / 1996

| Sr. <br> No. | Code Name | Nominal Alu. area | Size <br> Nos./mm | Approximate Weight in $\mathrm{kg} / \mathrm{km}$ |  |  |
| :---: | :---: | :---: | :---: | :---: | :---: | :---: |
|  |  |  |  | Aluminium | Steel | (Complete conductor) Total |
| 1 | Mole | 10 | $6+1 / 1.50$ | 29.0 | 14.0 | 43.0 |
| 2 | Squirrel | 18 | $6+1 / 1.96$ | 49.5 | 23.5 | 73.0 |
| 3 | Squirrel | 20 | $6+1 / 2.11$ | 58 | 27 | 85 |
| 4 | Gopher* | 16 | $6+1 / 2.36$ | 72 | 34 | 106 |
| 5 | Weasel | 30 | $6+1 / 2.59$ | 87 | 41 | 128 |
| 6 | Fox* | 23 | $6+1 / 2.79$ | 100 | 48 | 148 |
| 7 | Ferret* | 25 | $6+1 / 3.00$ | 116 | 55 | 171 |
| 8 | Rabbit | 50 | $6+1 / 3.35$ | 145 | 69 | 214 |
| 9 | Raccoon | 80 | $6+1 / 4.09$ | 215 | 104 | 319 |
| 10 | Mink* | 40 | $6+1 / 3.66$ | 173 | 82 | 255 |
| 11 | Horse* | 42 | 12+7/2.79 | 199 | 334 | 533 |
| 12 | Bever* | 45 | $6+1 / 3.99$ | 203 | 98 | 301 |
| 13 | Otter* | 50 | $6+1 / 4.22$ | 227 | 109 | 336 |
| 14 | Cat* | 55 | $6+1 / 4.50$ | 258 | 124 | 382 |
| 15 | Dog | 100 | $6 / 4.72+7 / 1.57$ | 287 | 107 | 394 |
| 16 | Leopard* | 130 | $6 / 5.28+7 / 1.75$ | 356 | 136 | 492 |
| 17 | Coyote* | 130 | 26/2.54+7/1.91 | 357 | 165 | 522 |
| 18 | Wolf | 150 | $30+7 / 2.59$ | 428 | 298 | 726 |
| 19 | LYRX* | 180 | $30+7 / 2.79$ | 497 | 347 | 844 |
| 20 | Panther | 200 | $30+7 / 3.00$ | 587 | 387 | 974 |
| 21 | Goat* | 320 | $30+7 / 3.71$ | 878 | 610 | 1488 |
| 22 | Drake | 400 | 26/4.44+7/3.45 | 1087 | 541 | 1628 |
| 23 | Kundah | 400 | 42/3.5+7/1.96 | 1114 | 168 | 1282 |
| 24 | Zebra | 420 | $54+7 / 3.18$ | 1186 | 435 | 1621 |
| 25 | Deer* | 420 | $30+7 / 4.27$ | 1163 | 816 | 1979 |
| 26 | Moose | 520 | $54+7 / 3.53$ | 1466 | 536 | 2002 |
| 27 | Morkulla | 560 | $42 / 4.13+7 / 2.30$ | 1523 | 258 | 1781 |
| 28 | Bersimis | 690 | $42 / 4.57+7 / 2.54$ | 1903 | 284 | 2187 |
| 29 | Bear* | 250 | $30 / 3.35+7 / 3.35$ | 651 | 497 | 1143 |
| 30 | Lion* | 230 | $30 / 3.18+7 / 3.18$ | 657 | 443 | 1100 |
| 31 | Sheep* | 350 | $30 / 3.99+7 / 3.99$ | 1035 | 691 | 1726 |
| 32 | EK* | 460 | $30 / 4.50+7 / 4.50$ | 1317 | 887 | 2204 |
| 33 | Camel* | 460 | $54 / 3.35+7 / 3.35$ | 1314 | 492 | 1806 |

Note: Code name and sizes marked *, though not appearing in IS in particular, these ranges can be supplied confirming to IS 398 (P.II) / 1996

## IS: 398 - Part I / 1978 (ALUMINIUM STRANDED CONDUCTOR)

1. Spools offered for inspection shall be divided* into equal lots, the number of lots being equal to the number of samples to be selected, a fraction of a lot being counted as a complete lot. One sample spool shall be selected at random from each lot.
2. Breaking Load Test - The breaking load of one specimen cut from each of the sample taken shall be determined by means of a suitable tensile testing machine. The load shall be applied gradually and the rate of separation of the jaws of the testing machine shall be not less than $25 \mathrm{~mm} / \mathrm{min}$ and not greater than $100 \mathrm{~mm} / \mathrm{min}$.
The ultimate breaking load of the specimen shall be not less than the appropriate value specified in Table 1.
3. Wrapping Test - One specimen cut from each of the samples taken shall be wrapped round a mandrel of diameter equal to the wire diameter to form a close helix of 8 turns. Six turns shall then be unwrapped and again closely wrapped in the same direction as before. The wire shall not break or show any crack.
4. Resistance Test - The electrical resistance of one specimen cut from each of the samples taken shall be measured at ambient temperature. The measured resistance shall be corrected to the value at $20^{\circ} \mathrm{C}$ by means of the formula:

| $\mathrm{R}_{20}$ | $=\mathrm{RT} \frac{1}{1+\alpha(T-20)}$ |
| ---: | :--- |
| Where $\quad$ |  |
| $R_{20}$ | $=$ resitance corrected at $20^{\circ} \mathrm{C}$. |
| $\mathrm{R}_{\mathrm{T}}$ | $=$ resitance measured at $\mathrm{T}^{\circ} \mathrm{C}$. |
| a | $=$ constant - mass temperature coefficient of resistance, 0.004, |
| T | $=$ and |

The resistance corrected at $20^{\circ} \mathrm{C}$ shall be not more than the maximum value specified in Table 1.

## 12. REJECTIONAND RETEST

12.1 Should any specimen not fulfil any of the test requirements, the particular coil from which the sample was taken shall be withdrawn. In respect of each failure, two specimen shall be selected from two different coils in the lot and subjected to the test in which failure occurred. If either of the two specimen fails to pass that test, the lot shall be rejected.
12.2 If any selected coil fails after retest, the manufacturer may test each coil and submit those for further inspection.

TABLE-1: ALUMINIUM WIRES USED IN THE CONSTRUCTION OF ALUMINIUM STRANDED CONDUCTORS
(Clauses 4.1,6.1.1,6.1.2,11.2 and 11.4) (IS: 398 -Part I/1976)

| Diameter |  |  | Cross Sectional Area of Nominal Diameter Wire | Mass | Resistance at $20^{\circ} \mathrm{C}$, Maximum | Breaking Load Minimum |  |
| :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: |
| Nom | Min | Max |  |  |  | Before Standing | After Standing |
| (1) | (2) | (3) | (4) | (5) | (6) | (7) | (8) |
| mm | mm | mm | $\mathrm{mm}^{2}$ | kg/km | $\Omega / \mathrm{km}$ | kN | kN |
| 2.21 | 2.19 | 2.23 | 3.836 | 10.37 | 7.553 | 0.68 | 0.65 |
| 3.10 | 3.07 | 3.13 | 7.548 | 20.40 | 3.843 | 1.24 | 1.18 |
| 3.18 | 3.15 | 3.21 | 7.942 | 21.47 | 3.651 | 1.29 | 1.23 |
| 3.99 | 3.95 | 4.03 | 12.50 | 33.80 | 2.322 | 1.98 | 1.88 |
| 4.39 | 4.35 | 4.43 | 15.14 | 40.91 | 1.194 | 2.40 | 2.28 |
| 4.65 | 4.60 | 4.70 | 16.98 | 45.90 | 1.712 | 2.70 | 2.56 |

## Note:

1. The resistance has been calculated from the maximum values of resistivity and the cross-sectional area based on the minimum diameter.
2. The resistance of that individual wires shall be such that the completed standard conductor meets the requirements of the maximum resistance specified in the Table 2calculated by applying the relevant stranding constants given in Table 4.

TABLE 2 ALUMINIUM STRANDED CONDUCTORS
Clauses 6.2.1, 6.2.2, and Table 1 (Note 2) (IS: 398 - Part I / 1976)

| Nominal Aluminium Area | Stranding And Wire Diameter | Sectional Area | Approximate Overall Diameter | Approximate Mass | Calculated Resistance at $20^{\circ} \mathrm{C}$, Max | Approximate Calculated <br> Breaking Load |
| :---: | :---: | :---: | :---: | :---: | :---: | :---: |
| 1 | 2 | 3 | 4 | 5 | 6 | 7 |
| $\mathrm{mm}^{2}$ | mm | $\mathrm{mm}^{2}$ | mm | $\mathrm{kg} / \mathrm{km}$ | $\Omega / \mathrm{km}$ | kN |
| 25 | 7/2.21 | 26.85 | 6.63 | 74 | 1.093 | 4.52 |
| 50 | 7/3.10 | 52.83 | 9,30 | 145 | 0.5561 | 8.25 |
| 100 | 7/4.39 | 106.0 | 131.7 | 290 | 0.2770 | 15.96 |
| 150 | 19/3.18 | 150.9 | 15.90 | 415 | 0.1956 | 23.28 |
| 240 | 19/3.99 | 237.6 | 19.95 | 654 | 0.1244 | 35.74 |
| 300 | 19/4.65 | 322.7 | 23.25 | 888 | 0.09171 | 48.74 |

Note:

1. For the basis of calculation of this table. see appendix. $A$
2. The Sectional area of a stranded conductor has been taken as the sum of the cross sectional areas of the individual wires.

## TABLE 3 LAY RATIOS FOR ALUMINIUM STRANDED CONDUCTORS

(Clauses 8.2 and A-2-3) (IS: 398 - Part I / 1976)

| Number of Wires in <br> Conductor | Lay Ratio |  |  |  |
| :---: | :---: | :---: | :---: | :---: |
|  | 6 Wire Layer |  | 12 Wire Layer |  |
|  | Min | Max | Min | Max |
| 1 | 2 | 3 | 4 | 5 |
| 7 | 10 | 14 | - | - |
| 19 | 10 | 16 | 10 | 14 |

## NOTES ON THE CALCULATION OF TABLE 2 <br> A-1 INCREASE IN LENGTH DUE TO STRANDING

A-1.1 When straightned out, each wire in any particular layer of a stranded conductor, except the central wire, is longer than the stranded conductor by an amount depending on the lay ratio of that year.

## A-2 RESISTANCE AND MASS OF CONDUCTOR

A-2.1 The resistance of any length of a standard conductor is the resistance of the same length of any one wire multiplied by a constant, as set out in Table 4.

A-2.2 The mass of each wire in any particular layer of stranded conductor, except the central wire, will be greater than that of an equal length of straight wire by an amount depending on the lay ratio of that layer (see A-1.1 above). The total mass of any length of an aluminum stranded conductor is, therefore obtained by multiplying the mass of an equal length of straight wire by an appropriate constant, as set out in Table 4.
A-2.3 In calculating the stranding constants in Table 4, the mean lay ratio, that is the arithmetic mean of the relevant minimum and maximum values in Table 3, has been assumed for each layer.

## A-3 CALCULATED BREAKING LOAD OF CONDUCTOR

A-3.1 The breaking load of an aluminum stranded conductor containing not more than 37 wires, in terms of the strengths of the individual component wires, may be taken to be 95 percent of the sum of the strengths of the individual aluminium wires calculated from the specified minimum tensile strength.

TABLE 4: STRANDING CONSTANTS
(Clauses A-2.1, A-2.2, A-2.3 and Table 1 (Note 2))

| Number of Wires In Conductor | Stranding Constants |  |
| :---: | :---: | :---: |
|  | Mass | Electrical Resistance |
| 1 | 2 | 3 |
| 7 | 7.091 | 0.1447 |
| 19 | 19.34 | 0.05357 |

MODULUS OF ELASTICITY AND COEFFICIENT OF LINEAR EXPANSION
(Clause 0.5) (IS: 398 - Part I / 1976)

| No. of Wires | Final Modulus of Elasticity <br> (Practical) $\mathrm{GN} / \mathrm{m}^{2}$ | Coefficient of Linear <br> Expansion $/{ }^{\circ} \mathrm{C}$ |
| :---: | :---: | :---: |
| 7 | 59 | $23.0 \times 10^{4}$ |
| 19 | 60 | $23.0 \times 10^{4}$ |

Note:

1. These values are given for information only.
2. Modulivalues quoted may be regarded as being accurate to within $3 \mathrm{GN} / \mathrm{m}^{2}$.
3. Moduli values quoted may be taken as applying to conductors stressed between 15 and 50 percent of the ultimate strength of the conductor.

TABLE 1 ALUMINIUM WIRES USED IN THE CONSTRUCTION OF ALUMINIUM STRANDED CONDUCTORS
(Clauses 4.1, 6.1.1, 6.1.2, 11.2 and 11.4) (Clause 0.5) (IS: 398 - Part I / 1976 - Amendment 2 / July '93)

| Diameter |  |  | Cross Sectional Area of Nominal Diameter Wire | Mass | Resistance at $20^{\circ} \mathrm{C}$, Maximum | Breaking Load Minimum |  |
| :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: |
| Nom | Minimum | Maximum |  |  |  | Before Standing | After Standing |
| mm | mm | mm | $\mathrm{mm}^{2}$ | kg/km | $\Omega / \mathrm{km}$ | kN | kN |
| 2.21 | 2.19 | 2.23 | 3.836 | 10.37 | 7.503 | 0.68 | 0.65 |
| 3.10 | 3.07 | 3.13 | 7.548 | 20.40 | 3.818 | 1.24 | 1.18 |
| 3.18 | 3.15 | 3.21 | 7.942 | 21.47 | 3.626 | 1.29 | 1.23 |
| 3.99 | 3.95 | 4.03 | 12.50 | 33.80 | 2.306 | 1.98 | 1.88 |
| 4.39 | 4.35 | 4.43 | 15.14 | 40.91 | 1.902 | 2.40 | 2.28 |
| 4.65 | 4.60 | 4.70 | 16.98 | 45.90 | 1.700 | 2.70 | 2.56 |

## Note:

1. The resistance has been calculated from the maximum values of resistivity and the cross-sectional area based on the minimum diameter.
2. The resistance of that individual wires shall be such that the completed standard conductor meets the requirements of the maximum resistance specified in the table 2 calculated by applying the relevant stranding constants given in table 4.

## DICABS

TABLE 2 ALUMINIUM STRANDED CONDUCTORS
Clauses 6.2.1, 6.2.2, and Table 1 (Note 2) (IS: 398 - Part I/ 1976 - Amendment 2 / July '93)

| Nominal <br> Aluminium <br> Area | Stranding <br> And Wire <br> Diameter | Sectional <br> Area | Approximate <br> Overall Diameter | Approximate <br> Mass | Calculated <br> Resistance at <br> $20{ }^{\circ} \mathrm{C}$, <br> Maximum | Approximate <br> Calculated <br> Breaking Load |
| :---: | :---: | :---: | :---: | :---: | :---: | :---: |
| $\mathrm{mm}^{2}$ | mm | $\mathrm{~mm}^{2}$ | mm | $\mathrm{~kg} / \mathrm{km}$ | $\Omega / \mathrm{km}$ | kN |
| 25 | $7 / 2.21$ | 26.85 | 6.63 | 74 | 1.086 | 4.52 |
| 50 | $7 / 3.10$ | 52.83 | 9.30 | 145 | 0.5525 | 8.25 |
| 100 | $7 / 4.39$ | 106.0 | 131.7 | 290 | 0.2752 | 15.96 |
| 150 | $19 / 3.18$ | 150.9 | 15.90 | 415 | 0.1942 | 23.28 |
| 240 | $19 / 3.99$ | 237.6 | 19.95 | 654 | 0.1235 | 35.74 |
| 300 | $19 / 4.65$ | 322.7 | 23.25 | 888 | 0.09107 | 48.74 |

## Note:

1. For the basis of calculation of this table, see appendix $A$
2. The Sectional area of a stranded conductor has been taken as the sum of the cross sectional areas of the individual wires.

## ALUMINIUM WIRES USED IN THE CONSTRUCTION OF ALUMINIUM CONDUCTORS. GALVANIZED STEEL-REINFORCED

(Clauses 5.1, 7.1.1, 1.2.1,12.2.1,12.5 and A-32) IS: 398 (part II) 1976

| Diameter |  |  | Cross Sectional | Mass | Resistance at <br> $20^{\circ} \mathrm{C}$ | Breaking Load |  |
| :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: |
| Nom | Minimum | Maximum | Area of Nominal <br> Diameter Wire. |  |  | Before <br> Stranding | After <br> Stranding |
| mm | mm | mm | $\mathrm{mm}^{2}$ | $\mathrm{Kg} / \mathrm{km}$ | $\Omega / \mathrm{km}$ | kN | kN |
| 1.50 | 1.48 | 1.52 | 1.767 | 4.78 | 16.54 | 0.32 | 0.30 |
| 1.96 | 1.94 | 1.98 | 3.017 | 8.16 | 9.625 | 0.54 | 0.59 |
| 2.11 | 2.09 | 2.13 | 3.497 | 9.45 | 8.293 | 0.63 | 0.60 |
| 2.59 | 2.56 | 2.62 | 5.269 | 14.24 | 5.527 | 0.89 | 0.85 |
| 3.00 | 2.97 | 3.03 | 7.069 | 19.11 | 4.107 | 1.17 | 1.11 |
| 3.18 | 3.15 | 3.21 | 7.942 | 21.47 | 3.651 | 1.29 | 1.23 |
| 3.35 | 3.32 | 3.38 | 8.814 | 23.82 | 3.286 | 1.43 | 1.36 |
| 3.50 | 3.46 | 3.54 | 9.621 | 26.01 | 3.026 | 1.55 | 1.47 |
| 3.53 | 3.49 | 3.57 | 9.787 | 26.45 | 2.974 | 1.57 | 1.49 |
| 3.80 | 3.76 | 3.84 | 11.34 | 30.65 | 2.562 | 1.80 | 1.71 |
| 4.09 | 4.05 | 4.13 | 13.14 | 35.51 | 2.208 | 2.08 | 1.98 |
| 4.13 | 4.09 | 4.17 | 13.40 | 36.21 | 2.165 | 2.13 | 2.02 |
| 4.72 | 4.64 | 4.77 | 17.50 | 47.30 | 1.661 | 2.78 | 2.64 |

## Note:

1. The resistance has been calculated from the maximum value of resistivity and the cross sectional area based on the minimum diameter.
2. The resistance of the individual wire shall be such that the completed stranded conductor meets the requirements of the maximum resistance specified in Table 3 calculated by applying the relevant standing constants given in table 5.

## STEEL WIRES USED IN THE CONSTRUCTION OF ALUMINIUM CONDUCTORS

 GALVANIZED STEEL-REINFORCED(Clauses 6.1,8.1.1, 13.2 and A-3.2) (IS: 398 (Part II) 1976)

| Diameter |  |  | Cross Sectional Area of <br> Nominal diameter Wire |  |  | Mreaking Load Minimum |  |  |
| :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: |
| Nom | Min | Max | Before <br> Stranding | After <br> Stranding |  |  |  |  |
| mm | mm | mm | $\mathrm{mm}^{2}$ | $\mathrm{~kg} / \mathrm{km}$ | kN | kN |  |  |
| 1.50 | 1.47 | 1.53 | 1.767 | 13.78 | 2.46 | 2.34 |  |  |
| 1.57 | 1.54 | 1.60 | 1.936 | 15.10 | 2.70 | 2.57 |  |  |
| 1.96 | 1.92 | 2.00 | 3.017 | 23.53 | 4.20 | 3.99 |  |  |
| 2.11 | 2.07 | 2.15 | 3.497 | 27.27 | 4.60 | 4.37 |  |  |
| 2.30 | 2.25 | 2.35 | 4.155 | 32.41 | 5.46 | 5.19 |  |  |
| 2.59 | 2.54 | 2.64 | 5.269 | 41.09 | 6.92 | 6.57 |  |  |
| 3.00 | 2.94 | 3.06 | 7.069 | 55.13 | 9.29 | 8.83 |  |  |
| 3.18 | 3.12 | 3.24 | 7.942 | 61.95 | 10.43 | 9.91 |  |  |
| 3.35 | 3.28 | 3.42 | 8.814 | 68.75 | 11.58 | 11.00 |  |  |
| 3.53 | 3.46 | 3.60 | 9.787 | 76.34 | 12.86 | 12.22 |  |  |
| 4.09 | 4.01 | 4.17 | 13.14 | 102.48 | 17.27 | 16.41 |  |  |

TABLE 1 ALUMINIUM WIRES USED IN THE CONSTRUCTION OF ALUMINIUM CONDUCTORS. GALVANIZED STEEL-REINFORCED (Clauses 6.1,8.1.1,8.12.1,13.2,13.31,13.5.1 and 13.6) (IS: 398 (Part II) 1996)

| Diameter |  |  | Cross Sectional Area of Nominal Diameter Wire | Mass | $\begin{array}{\|c\|} \hline \text { Resistance at } \\ 20^{\circ} \mathrm{C} \\ \text { Maximum } \\ \hline \end{array}$ | Breaking Load Min |  |
| :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: |
| Nom | Min | Max |  |  |  | Before Stranding | After Stranding |
| mm | mm | mm | $\mathrm{mm}^{2}$ | kg/km | $\Omega / \mathrm{km}$ | kN | kN |
| 1.50 | 1.48 | 1.52 | 1.767 | 4.78 | 16.432 | 0.32 | 0.30 |
| 1.96 | 1.94 | 1.98 | 3.017 | 8.16 | 9.561 | 0.54 | 0.59 |
| 2.11 | 2.09 | 2.13 | 3.497 | 9.45 | 8.237 | 0.63 | 0.60 |
| 2.59 | 2.56 | 2.62 | 5.269 | 14.24 | 5.490 | 0.89 | 0.85 |
| 3.00 | 2.97 | 3.03 | 7.069 | 19.11 | 4.079 | 1.17 | 1.11 |
| 3.18 | 3.15 | 3.21 | 7.942 | 21.47 | 3.626 | 1.29 | 1.23 |
| 3.35 | 3.32 | 3.38 | 8.814 | 23.82 | 3.265 | 1.43 | 1.36 |
| 3.50 | 3.46 | 3.54 | 9.621 | 26.01 | 3.006 | 1.55 | 1.47 |
| 3.53 | 3.49 | 3.57 | 9.787 | 26.45 | 2.954 | 1.57 | 1.49 |
| 3.80 | 3.76 | 3.84 | 11.34 | 30.65 | 2.545 | 1.80 | 1.71 |
| 4.09 | 4.05 | 4.13 | 13.14 | 35.51 | 2.194 | 2.08 | 1.98 |
| 4.13 | 4.09 | 4.17 | 13.40 | 36.21 | 2.151 | 2.13 | 2.02 |
| 4.72 | 4.64 | 4.77 | 17.50 | 47.30 | 1.650 | 2.78 | 2.64 |

## Note:

The resistance has been calculated from the maximum value of resistivity and the cross sectional area based on the minimum diameter.

TABLE 2 STEEL WIRES USED IN THE CONSTRUCTION OF ALUMINIUM CONDUCTORS GALVANIZED STEEL - REINFORCED
(Clauses 6.1,8.1.1,13.2, and A-3.2) (IS: 398 (Part II) 1996)

| Diameter |  |  | Cross Sectional Area of Nominal Diameter Wire | Mass | Breaking Load Minimum |  |
| :---: | :---: | :---: | :---: | :---: | :---: | :---: |
| Nom | Min | Max |  |  | Before Stranding | After Stranding |
| mm | mm | mm | $\mathrm{mm}^{2}$ | Kg/km | kN | kN |
| 1.50 | 1.47 | 1.53 | 1.767 | 13.78 | 2.46 | 2.34 |
| 1.57 | 1.54 | 1.60 | 1.936 | 15.10 | 2.70 | 2.57 |
| 1.96 | 1.92 | 2.00 | 3.017 | 23.53 | 4.20 | 3.99 |
| 2.11 | 2.07 | 2.15 | 3.497 | 27.27 | 4.60 | 4.37 |
| 2.30 | 2.25 | 2.35 | 4.155 | 32.41 | 5.46 | 5.19 |
| 2.59 | 2.54 | 2.64 | 5.269 | 41.09 | 6.92 | 6.57 |
| 3.00 | 2.94 | 3.06 | 7.069 | 55.13 | 9.29 | 8.83 |
| 3.18 | 3.12 | 3.24 | 7.942 | 61.95 | 10.43 | 9.91 |
| 3.35 | 3.28 | 3.42 | 8.814 | 68.75 | 11.58 | 11.00 |
| 3.53 | 3.46 | 3.60 | 9.787 | 76.34 | 12.86 | 12.22 |
| 4.09 | 4.01 | 4.17 | 13.14 | 102,48 | 17.27 | 16.41 |

## NOTES ON CALCULATION OF RESISTANCE, MASS AND BREAKING LOAD

## A-1 INCREASEIN LENGTH DUETO STRANDING

A-1.1 When straightened out, each wire in any particular layer of standard conductor, except the central wire, is longer than the stranded conductor by an amount depending on the lay ratio of that layer.

## A-2 RESISTANCEAND MASS OF CONDUCTOR

A-2.1 In aluminium conductors, steel reinforced the conductivity of the steel core is neglected and the resistance of the conductor is calculated with reference to the resistance of the aluminium wires only. The resistance of any length of any one aluminium wire multiplied by a constant, as set out in Table 5.

A-2.2 The mass of each wire in a length of stranded conductor, except the central wire, will be greater than that of an equal length of straight wire by an amount depending on the lay ratio of the layer (see A-1.1). The total mass of any length of conductor is therefore, obtained by multiplying the mass of an equal length of straight wire by the approximate constant set out in Table 5. The masses of the steel core and aluminium wires are calculated separately and added together.
A-2.3 In calculating the stranding constant in Table 5, the mean lay ratio, that is, the arithmetic mean of the relevant minimum and maximum values in Table 4, has been assumed for each layer.

## A-3 CALCULATED BREAKING LOAD OFCONDUCTOR

A-3.1 The breaking load of an aluminium conductor galvanised steel, reinforced in terms of the sum of the strength of the individual component wires, may be taken to be as follows:
(a) 98 percent of the sum of the breaking loads of the aluminium wires plus 89 percent of the sum of the breaking loads of the galvanized steel wires, when taken from the stranded conductor and tested: or
(b) 98 percent of the sum of the breaking loads of the aluminium wires plus 85 percent of the sum of the breaking loads of the galvanised steel wires, based on the minimum breaking loads of the component wires before stranding, that is in the coil.

A-3.2 The values of approximate breaking load of conductors, given in Table 3 have been calculated in accordance with (b) above and on the basis of the minimum breaking loads of the component wires given in Table 1 and 2.

MODULUS OF ELASTICITY AND COEFFICIENT OF LINEAR EXPANSION

| No. of wires |  | Final Modulus of Elasticity <br> (Practical) $\mathrm{GN} / \mathrm{m}^{2}$ | Coefficient of Linear <br> Expansion/ ${ }^{\circ} \mathrm{C}$ |
| :---: | :---: | :---: | :---: |
| Aluminium | Steel |  | $\mathbf{4}$ |
| $\mathbf{1}$ | $\mathbf{2}$ | 79 | $19.1 \times 10^{6}$ |
| 6 | 1 | 75 | $19.8 \times 10^{6}$ |
| 6 | 7 | 80 | $17.8 \times 10^{6}$ |
| 30 | 7 | 62 | $21.5 \times 10^{6}$ |
| 42 | 7 | 69 | $19.3 \times 10^{6}$ |
| 54 | 7 |  |  |

## NOTES

1. These values are given for information only.
2. Moduli values quoted may be regarded as being accurate to within $\pm 3 \mathrm{GN} / \mathrm{m}^{2}$
3. Moduli values quoted may be taken as applying to conductors stressed between 15 and 50 percent of the ultimate strength of the conductor.
4. Coefficient of linear expansion have been calculated from the final (practical) Moduli for the aluminium and steel components of the conductors and coefficients of linear expansion of $23.0 \times 10^{8}$ and $11.5 \times 10^{8} /{ }^{\circ} \mathrm{C}$ for aluminium and steel respectively.

## LAY RATIOS AND STRANDING CONSTANTS FOR NON STANDARD CONSTRUCTIONS

| 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 11 | 12 | 13 | 14 | 15 | 16 |
| :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: |
| Number of wires in conductor |  | Ratio al. <br> wire diameter to steel wire diameter | Lay ratios for steel core |  |  |  | Lay ratios for Aluminium wires |  |  |  |  |  | Standing constants |  |  |
|  |  | 6 -wire layer | 12-wire layer |  | Outside layer |  | Layer immediately beneath outside layer |  | Innermost layer of conductors with 3 Aluminium wire layers |  | Mass |  | Elect. <br> Resistance |
| Alum | Steel |  |  | Min | Max | Min | Max | Min | Max | Min | Max | Min | Max | Alum. | Steel |  |
| 24 | 7 | 1.500 | 13 | 28 |  | - | 10 | 14 | 10 | 16 | - | - | 24.50 | 7.032 | 0.04253 |
| 26 | 7 | 1.286 | 13 | 28 | - | - | 10 | 14 | 10 | 16 | . | . | 26.56 | 7.032 | 0.03928 |
| 28 | 7 | 1.125 | 13 | 28 | - | - | 10 | 14 | 10 | 16 | - | - | 28.61 | 7.032 | 0.03649 |
| 30 | 19 | 1.666 | 13 | 28 | 12 | 24 | 10 | 14 | 10 | 16 | - | - | 30.67 | 19.15 | 0.03408 |
| 42 | 7 | 1.800 | 13 | 28 | - | - | 10 | 14 | 10 | 16 | 10 | 17 | 42.90 | 7.032 | 0.02432 |
| 45 | 7 | 1.500 | 13 | 28 | - | - | 10 | 14 | 10 | 16 | 10 | 17 | 45.96 | 7.032 | 0.02271 |
| 49 | 7 | 1.286 | 13 | 28 |  | - | 10 | 14 | 10 | 16 | 10 | 17 | 49.06 | 7.032 | 0.02129 |
| 54 | 19 | 1.666 | 13 | 28 | 12 | 24 | 10 | 14 | 10 | 16 | 10 | 17 | 55.23 | 19.15 | 0.01894 |

## DICABS

## ALL ALUMINIUM CONDUCTOR GALVANIZED STEEL - REINFORCED

IS 398 Part 2/1996

| Nominal Aluminium | Stranding and wire diameter |  | Sectional area of Aluminium | Total sectional area | Approx. Diameter | Approx. Mass | Resistance at $20^{\circ} \mathrm{C}$ Maximum | Breaking load <br> Minimum |
| :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: |
|  | Aluminium | Steel |  |  |  |  |  |  |
| (1) | (2) | (3) | (4) | (5) | (6) | (7) | (8) | (9) |
| $\mathrm{mm}^{2}$ | mm | mm | $\mathrm{mm}^{2}$ | $\mathrm{mm}^{2}$ | mm | kg/km | $\Omega / \mathrm{km}$ | kN |
| 10 | 6/1.50 | 1/1.50 | 10.60 | 12.37 | 4.50 | 43 | 2.780 | 3.97 |
| 18 | 6/1.96 | 1/1.96 | 18.10 | 21.12 | 5.88 | 73 | 1.618 | 6.74 |
| 20 | 6/2.11 | 1/2.11 | 20.98 | 24.28 | 6.33 | 85 | 1.394 | 7.61 |
| 30 | 6/2.59 | 1/2.59 | 31.61 | 36.88 | 7.77 | 128 | 0.9289 | 11.12 |
| 50 | 6/3.35 | 1/3.35 | 52.88 | 61.70 | 10.05 | 214 | 0.5524 | 18.25 |
| 80 | 6/4.09 | 1/4.09 | 78.83 | 91.97 | 12.27 | 319 | 0.3712 | 26.91 |
| 100 | 6/4.72 | 7/1,57 | 105.0 | 118.5 | 14.15 | 394 | 0.2792 | 32.41 |
| 150 | 30/2.59 | 7/2.59 | 158.1 | 194.9 | 18.13 | 726 | 0.1871 | 67.34 |
| 200 | 30/3.00 | 7/3,00 | 212.1 | 261.5 | 21.00 | 974 | 0.1390 | 89.67 |
| 400 | 42/3.50 | 7/1.96 | 404.1 | 425.2 | 26.88 | 1281 | 0.07311 | 88.79 |
| 420 | 54/3.18 | 7/3.18 | 428.9 | 484.5 | 28.62 | 1621 | 0.06868 | 130.32 |
| 520 | 54/3.53 | 7/3.53 | 528.5 | 597.0 | 31.77 | 1998 | 0.05595 | 159.60 |
| 560 | 42/4.13 | 7/2.30 | 562.7 | 591.7 | 31.68 | 1781 | 0.05231 | 120.16 |

## CHEMICAL COMPOSITION OF HIGH CARBON STEEL

C-1 The chemical composition of high carbon steel used in the manufacture of steel wire of ACSR conductor is given below for guidance:

| Element | Percentage composition |
| :---: | :---: |
| Carbon | 0.50 to 0.8, |
| Manganese | 0.50 to, 1.10 |
| Phosphorus | Max, 100.035 |
| Sulphur | Klax 0.045 |
| Silicon | 0.10 to 0.35 |

Lay Ratios of Aluminium conductors, Galvanized Steel-Reinforced
(Clauses 10.2,10.3, and 13.8)

| Number of Wires |  | Ratio of Aluminium wire Diameter To steel Wire Diameter | Lay Ratios for Aluminium Wire |  |  |  |  |  |  |  |
| :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: |
|  |  | Lay Ratios for Steel core 16 wire Layer) Min | Outermost <br> layer <br> Max | Layer immediately beneath Outermost layer |  | Innermost Layer of Conductors with 3 Aluminium Wire Layers |  |  |  |
| Alu. | Steel |  |  | Min | Max | Min | Max | Min | Max |
| 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 11 |
| 6 | 1 | 1.0 | $\cdot$ | - | 10 | 14 | - | - | - | - |
| 6 | 7 | 3.0 | 1.3 | 28 | 10 | 14 | . | - | - | - |
| 30 | 7 | 1.0 | 1.3 | 28 | 10 | 14 | 10 | 16 | $\cdot$ | - |
| 42 | 7 | 1.8 | 1.3 | 28 | 10 | 14 | 10 | 16 | 10 | 17 |
| 54 | 7 | 1.0 | 1.3 | 28 | 10 | 14 | 10 | 16 | 10 | 17 |

## Stranding Constants

(Table I and Clauses 13.6, A-2, 1, A-2, 2 and A-2, 3, 1)

| Number of Wires in Conductor |  | Mass <br> Aluminium | Stranding Constant |  |
| :---: | :---: | :---: | :---: | :---: |
| Aluminium | Steel |  |  |  |
| $(1)$ | $(2)$ | $(3)$ | $(4)$ | $(5)$ |
| 6 | 0 | 6.091 | 1.000 | 0.1692 |
| 6 | 7 | 6.091 | 7.032 | 0.1692 |
| 30 | 7 | 30.67 | 1.032 | 0.03408 |
| 42 | 7 | 42.90 | 7.032 | 0.02432 |
| 54 | 7 | 55.23 | 7.032 | 0.01894 |

GROUND WIRES FOR TRANSMISSION LINES - COMMONLY USE SIZES AAAC WIRES

| Sr. No | Description |  | Unit | 19/200 |  | 7/3.81 |  | 19/2.46 |  |
| :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: |
| 1 | Nominal area |  | sq. mm |  | 60 |  | 80 |  | 90 |
| 2 | Sectional area |  |  |  |  |  |  |  |  |
|  | AAAC |  | sq. mm |  | 59.70 |  | 79.81 |  | 90.31 |
|  | Steel |  | sa. mm |  | - |  | - |  | - |
|  | Total |  | sq. mm |  | 59.70 |  | 79.81 |  | 90.31 |
| 3 | Over all diameter |  | mm |  | 10.00 |  | 11.43 |  | 12.30 |
| 4 | Approximate mass |  | kg/mm |  | 164 |  | 218 |  | 248 |
| 5 | Rated Strength |  | $\begin{array}{\|l\|} \hline \mathrm{kN} \\ \mathrm{kgf} \\ \hline \end{array}$ |  | $\begin{array}{r} 17.56 \\ 1790 \\ \hline \end{array}$ |  | $\begin{array}{r} 23.41 \\ 2387 \\ \hline \end{array}$ |  | $\begin{array}{r} 3.30 \\ 2576 \\ \hline \end{array}$ |
| 6 | Modulus of elasticity |  | kg sq. mm |  | $0.57 \times 10$ |  | 0.6× 10 |  | $0.57 \times 10$ |
| 7 | coefficients of linear expansion ${ }^{\circ} \mathrm{C}$ |  | per |  | $23.0 \times 10$ |  | $23.0 \times 10$ |  | $23.0 \times 10$ |
| 8 | Electrical resistance |  | ohms |  | 0.552 |  | 0.4125 |  | 0.3663 |
| 9 | Tension / Sag |  |  | T | S | T | S | T | S |
|  | Span (m) | Temp (C) |  | (Kg f) | (m) | ( Kg f ) | (m) | (Kg f) | (m) |
|  | 260 | $\begin{aligned} & 32 \\ & 53 \\ & \hline \end{aligned}$ |  | $\begin{aligned} & 358 \\ & 293 \\ & \hline \end{aligned}$ | $\begin{aligned} & 03.87 \\ & 04.73 \\ & \hline \end{aligned}$ | $\begin{aligned} & 477 \\ & 389 \\ & \hline \end{aligned}$ | $\begin{array}{r} 03.86 \\ 0.7 \\ \hline \end{array}$ | $\begin{aligned} & 515 \\ & 425 \\ & \hline \end{aligned}$ | $\begin{aligned} & 04.07 \\ & 04.93 \\ & \hline \end{aligned}$ |
|  | 275 | $\begin{aligned} & 32 \\ & 53 \\ & \hline \end{aligned}$ |  | $\begin{aligned} & 358 \\ & 297 \\ & \hline \end{aligned}$ | $\begin{aligned} & 04.33 \\ & 05.23 \\ & \hline \end{aligned}$ | $\begin{array}{r} 77 \\ 394 \\ \hline \end{array}$ | $\begin{aligned} & 04.32 \\ & 05.24 \\ & \hline \end{aligned}$ | $\begin{aligned} & 515 \\ & 430 \\ & \hline \end{aligned}$ | $\begin{aligned} & 04.55 \\ & 05.45 \\ & \hline \end{aligned}$ |
|  | 320 | $\begin{aligned} & 32 \\ & 53 \\ & \hline \end{aligned}$ |  | $\begin{aligned} & 358 \\ & 306 \\ & \hline \end{aligned}$ | $\begin{aligned} & 05.86 \\ & 06.86 \end{aligned}$ | $\begin{aligned} & 477 \\ & 407 \\ & \hline \end{aligned}$ | $\begin{aligned} & 05.85 \\ & 06.86 \end{aligned}$ | $\begin{aligned} & 515 \\ & 444 \\ & \hline \end{aligned}$ | $\begin{aligned} & 06.16 \\ & 07.16 \end{aligned}$ |
|  | 350 | $\begin{aligned} & 32 \\ & 53 \end{aligned}$ |  | $\begin{aligned} & 358 \\ & 311 \\ & \hline \end{aligned}$ | $\begin{aligned} & 07.01 \\ & 08.07 \\ & \hline \end{aligned}$ | $\begin{aligned} & 477 \\ & 414 \\ & \hline \end{aligned}$ | $\begin{aligned} & 07.00 \\ & 08.07 \\ & \hline \end{aligned}$ | $\begin{aligned} & 515 \\ & 451 \\ & \hline \end{aligned}$ | $\begin{aligned} & 07.37 \\ & 08.42 \\ & \hline \end{aligned}$ |
|  | 380 | $\begin{aligned} & 32 \\ & 53 \\ & \hline \end{aligned}$ |  | $\begin{aligned} & 358 \\ & 316 \\ & \hline \end{aligned}$ | $\begin{aligned} & 08.27 \\ & 09.37 \\ & \hline \end{aligned}$ | $\begin{aligned} & 477 \\ & 420 \\ & \hline \end{aligned}$ | $\begin{aligned} & 08.25 \\ & 09.37 \\ & \hline \end{aligned}$ | $\begin{aligned} & 515 \\ & 458 \\ & \hline \end{aligned}$ | $\begin{aligned} & \hline 08.69 \\ & 09.78 \\ & \hline \end{aligned}$ |
|  | 400 | $\begin{aligned} & 32 \\ & 53 \end{aligned}$ |  | $\begin{aligned} & 358 \\ & 319 \end{aligned}$ | $\begin{aligned} & 09.16 \\ & 10.29 \\ & \hline \end{aligned}$ | $\begin{aligned} & 477 \\ & 424 \\ & \hline \end{aligned}$ | $\begin{aligned} & 09.14 \\ & 10.24 \\ & \hline \end{aligned}$ | $\begin{aligned} & 515 \\ & 462 \end{aligned}$ | $\begin{aligned} & 09.63 \\ & 10.75 \end{aligned}$ |

GROUND WIRES FOR TRANSMISSION LINES - COMMONLY USE SIZES
Galvanized Steel Wires

| Sr. No | Description |  | Unit | 7/3.15 |  | 7/3.66 |  | 7/4.06 |  |
| :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: |
| 1 | Nominal area |  | sq. mm |  | 55 |  | 75 |  | 90 |
| 2 | Sectional area |  |  |  |  |  |  |  |  |
|  | AAAC |  | sq. mm |  | $\cdot$ |  | $\cdot$ |  | - |
|  | Steel |  | sq. mm |  | 54.55 |  | 73.65 |  | 90.62 |
|  | Total |  | sq. mm |  | 54.55 |  | 73.65 |  | 90.62 |
| 3 | Over all diameter |  | mm |  | 9.45 |  | 10.98 |  | 12.18 |
| 4 | Approximate mass |  | $\mathrm{kg} / \mathrm{mm}$ |  | 428 |  | 575 |  | 706 |
| 5 | Rated Strength |  | $\begin{array}{\|l\|} \hline \mathrm{kN} \\ \mathrm{~kg} \end{array}$ |  | $\begin{array}{r} 56 \\ 5710 \\ \hline \end{array}$ |  | $\begin{aligned} & 79.77 \\ & 8134 \\ & \hline \end{aligned}$ |  | $\begin{array}{r} 980.16 \\ 10010 \end{array}$ |
| 6 | Modulus of elasticity |  | $\begin{array}{\|l\|} \hline \mathrm{kg} \\ \mathrm{sq} . \mathrm{mm} \\ \hline \end{array}$ |  | $1.933 \times 10^{6}$ |  | $1.933 \times 10^{-6}$ | 1.93 | $\times 10^{-6}$ |
| 7 | Coefficients of linear expansion ${ }^{\circ} \mathrm{C}$ |  | per |  | $11.5 \times 10^{6}$ |  | $11.5 \times 10^{6}$ |  | $\times 10^{-6}$ |
| 8 | Electrical resistance at $20^{\circ} \mathrm{C}$ |  | ohms/kms |  | 3.375 |  | 2.500 |  | 2.0318 |
| 9 | Tension / Sag |  |  | T | S | T | S | T | S |
|  | Span (m) | Temp (C) |  | ( Kg f$)$ | (m) | $(\mathrm{Kg} \mathrm{f})$ | (m) | ( Kg f$)$ | (m) |
|  | 260 | $\begin{aligned} & 32 \\ & 53 \end{aligned}$ |  | $\begin{aligned} & 1142 \\ & 1007 \end{aligned}$ | $\begin{aligned} & 3.17 \\ & 3.59 \end{aligned}$ | $\begin{aligned} & 1627 \\ & 1430 \\ & \hline \end{aligned}$ | $\begin{aligned} & 2.99 \\ & 3.40 \\ & \hline \end{aligned}$ | $\begin{aligned} & 2002 \\ & 1760 \end{aligned}$ | $\begin{aligned} & 2.98 \\ & 3.39 \\ & \hline \end{aligned}$ |
|  | 275 | $\begin{aligned} & 32 \\ & 53 \end{aligned}$ |  | $\begin{aligned} & 1142 \\ & 1013 \\ & \hline \end{aligned}$ | $\begin{aligned} & 3.54 \\ & 3.99 \end{aligned}$ | $\begin{aligned} & 1627 \\ & 1439 \\ & \hline \end{aligned}$ | $\begin{aligned} & 3.78 \\ & 3.78 \\ & \hline \end{aligned}$ | $\begin{aligned} & 2002 \\ & 1770 \end{aligned}$ | $\begin{aligned} & 3.33 \\ & 3.77 \\ & \hline \end{aligned}$ |
|  | 320 | $\begin{aligned} & 32 \\ & 53 \end{aligned}$ |  | $\begin{aligned} & 1142 \\ & 1041 \\ & \hline \end{aligned}$ | $\begin{aligned} & 4.80 \\ & 6.30 \\ & \hline \end{aligned}$ | $\begin{aligned} & 1627 \\ & 1477 \\ & \hline \end{aligned}$ | $\begin{aligned} & 4.52 \\ & 5.96 \\ & \hline \end{aligned}$ | $\begin{aligned} & 2002 \\ & 1817 \\ & \hline \end{aligned}$ | $\begin{aligned} & 4.51 \\ & 5.02 \\ & \hline \end{aligned}$ |
|  | 350 | $\begin{aligned} & 32 \\ & 53 \end{aligned}$ |  | $\begin{aligned} & 1142 \\ & 1041 \end{aligned}$ | $\begin{aligned} & 5.74 \\ & 6.30 \end{aligned}$ | $\begin{aligned} & 1627 \\ & 1477 \end{aligned}$ | $\begin{aligned} & 5.41 \\ & 5.96 \end{aligned}$ | $\begin{aligned} & 2002 \\ & 1817 \end{aligned}$ | $\begin{aligned} & 5.40 \\ & 5.95 \\ & \hline \end{aligned}$ |
|  | 380 | $\begin{aligned} & 32 \\ & 53 \end{aligned}$ |  | $\begin{aligned} & 1142 \\ & 1050 \\ & \hline \end{aligned}$ | $\begin{aligned} & 6.76 \\ & 7.36 \\ & \hline \end{aligned}$ | $\begin{aligned} & 1627 \\ & 1490 \end{aligned}$ | $\begin{aligned} & 6.38 \\ & 6.97 \end{aligned}$ | $\begin{aligned} & 2002 \\ & 1833 \end{aligned}$ | $\begin{aligned} & 6.37 \\ & 6.95 \\ & \hline \end{aligned}$ |
|  | 400 | $\begin{aligned} & 32 \\ & 53 \end{aligned}$ |  | $\begin{aligned} & 1142 \\ & 1056 \\ & \hline \end{aligned}$ | $\begin{aligned} & \hline 7.50 \\ & 8.11 \\ & \hline \end{aligned}$ | $\begin{aligned} & 1627 \\ & 1497 \end{aligned}$ | $\begin{aligned} & 7.07 \\ & 7.68 \\ & \hline \end{aligned}$ | $\begin{aligned} & 2002 \\ & 1842 \end{aligned}$ | $\begin{aligned} & 7.05 \\ & 7.67 \\ & \hline \end{aligned}$ |

## DEAD END COMPRESSION CLAMPS

| Sr. <br> No. | CONDUCTOR |  |  | A1 | A2 | B | C | D | E |
| :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: |
|  | Normal Alu. Area | Construction | Outer Diameter |  |  |  |  |  |  |
|  | Sq. mm | Nos. / mm | mm | mm | mm | mm | mm | mm | mm |
| 1 | 100 | 19/2.79 | 13.95 | 280 | 250 | 30 | 15.50 | 29.4 | 25 |
| 2 | 150 | 37/2.49 | 17.43 | 350 | 314 | 33 | 19.1 | 32.6 | 28 |
| 3 | 200 | 37/2.88 | 20.16 | 405 | 363 | 38 | 22.1 | 37.0 | 32 |
| 4 | 300 | 37/3.19 | 22.33 | 457 | 399 | 38 | 24.2 | 37.0 | 32 |
| 5 | 400 | 37/3.92 | 27.44 | 550 | 494 | 48 | 29.45 | 46.0 | 40 |
| 6 | 420 | 61/3.19 | 28.71 | 620 | 517 | 48 | 31.0 | 46.0 | 40 |
| 7 | 520 | 61/3.55 | 31.95 | 640 | 575 | 54 | 34.5 | 53.0 | 46 |
| 8 | 560 | 61/3.68 | 33.12 | 665 | 596 | 54 | 35.7 | 53.0 | 46 |

NOTE:
The dimensions after compression are same as that MID SPAN JOINT. It is not a general practice for utility to use DEAD END CLAMP COMPRESSION upto $80 \mathrm{sq} . \mathrm{mm}$. All dimensions are in mm .


## MID SPAN COMPRESSION JOINT FOR AAA CONDUCTORS.

| SL. <br> No. | CONDUCTOR |  |  | A | B | C | D | E |
| :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: |
|  | NORMAL ALU AREA | CONSTRUCTION | Outer DIAMETER |  |  |  |  |  |
|  | Sq. mm | Nos./mm | mm | mm | mm | mm | Mm | mm |
| 1 | 100 | 19/2.79 | 13.95 | 350 | 30 | 15.50 | 29.40 | 25 |
| 2 | 150 | 37/2.49 | 17.43 | 440 | 33 | 19.10 | 32.60 | 28 |
| 3 | 200 | 37/2.88 | 20.16 | 510 | 38 | 22.10 | 37.00 | 32 |
| 4 | 300 | 37/3.19 | 22.33 | 610 | 38 | 24.20 | 37.00 | 32 |
| 5 | 400 | 37/3.92 | 27.44 | 690 | 48 | 29.45 | 46.00 | 40 |
| 6 | 420 | 61/3.19 | 28.71 | 711 | 48 | 31.00 | 46.00 | 40 |
| 7 | 520 | 61/3.55 | 31.95 | 800 | 54 | 34.50 | 53.00 | 46 |
| 8 | 560 | 61/3.68 | 33.12 | 830 | 54 | 35.70 | 53.00 | 46 |



## REPAIR SLEEVE

| $\begin{aligned} & \text { SL. } \\ & \text { NO. } \end{aligned}$ | CONDUCTOR |  |  | A | B | C | D | E |
| :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: |
|  | NORMAL ALU. AREA | CONSTRUCTION | Outer DIAMETER |  |  |  |  |  |
|  | Sq. mm | Nos./mm | mm | mm | mm | mm | mm | mm |
| 1 | 100 | 19/2.79 | 13.95 | 139 | 30 | 15.5 | 29.4 | 25 |
| 2 | 150 | 37/2.49 | 17.43 | 175 | 33 | 19.1 | 32.6 | 28 |
| 3 | 200 | 37/2.88 | 20.16 | 210 | 38 | 22.1 | 37.0 | 32 |
| 4 | 300 | 37/3.19 | 22.33 | 241 | 38 | 24.2 | 37.00 | 32 |
| 5 | 400 | 37/2.92 | 27.44 | 275 | 48 | 29.45 | 46.00 | 40 |
| 6 | 420 | 61/3.19 | 28.71 | 287 | 48 | 31.0 | 46.00 | 40 |
| 7 | 520 | 61/3.55 | 31.95 | 320 | 54 | 34.5 | 53.00 | 46 |
| 8 | 560 | 61/3.68 | 33.12 | 332 | 54 | 35.7 | 53.00 | 46 |



CONDUCTOR PACKING: DRUM DIMENSIONS TO IS 1778/1980

| Drum Component (mm) | Constructional Details for Drum Components |  |  |  |  |
| :---: | :---: | :---: | :---: | :---: | :---: |
| 1 | 2 | 3 | 4 | 5 | 6 |
| Flange diameter | 965 | 1065 | 1195 | 1220 | 1345 |
| Barrel diameter | 585 | 600 | 600 | 600 | 600 |
| Traverse | 510 | 710 | 710 | 710 | 710 |
| Flange thickness | $2 \times 25$ | $2 \times 32$ | $2 \times 32$ | $2 \times 32$ | $2 \times 32$ |
| Bore Diameter | 80 | 80 | 80 | 80 | 80 |
| Nail Circle | 3 | 5 | 5 | 5 | 5 |
| Nail length | 65 | 75 | 75 | 75 | 75 |
| Nail Size (Min.) | 3.25 | 3.25 | 3.25 | 3.25 | 3.25 |
| Thickness of Barrel end supports | 38 | 38 | 38 | 38 | 38 |
| Thickness of Barrel end lagging | 38 | 38 | 38 | 38 | 38 |
| No. of stretchers | 4 | 4 | 4 | 4 | 4 |
| Stretchers size | $100 \times 38$ | $100 \times 38$ | $100 \times 38$ | 100x 38 | $100 \times 38$ |
| No. of Bolts | 4 | 4 | 4 | 4 | 4 |
| Diameter of bolts (Min.) | 12 | 12 | 12 | 12 | 12 |
| Size of square washer | $50 \times 6$ | $50 \times 6$ | $50 \times 6$ | $50 \times 6$ | $50 \times 6$ |
| Size of spindle plate | $150 \times 150 \times 6$ | 150×150x6 | 150x 150x 6 | 150× 150×6 | 150x 150x 6 |
| Diameter of spindle plate hole | 90 | 90 | 90 | 90 | 90 |
| No, of Spindle plate bolt | 4 | 4 | 4 | 4 | 4 |
| Spindle plate bolt diameter | 12 | 12 | 12 | 12 | 12 |
| Thickness of external logging | 38 | 38 | 38 | 38 | 38 |
| No. of binders over external lagging | 2 | 2 | 2 | 2 | 2 |



Fig. 1 Drum Nomenclature

CONDUCTOR PACKING: DRUM DIMENSIONS TO IS 1778/1980

| Drum <br> Component | Constructional Details for Drum Components |  |  |  |  |  |
| :--- | :---: | :---: | :---: | :---: | :---: | :---: |
| 1 | 7 | 8 | 9 | 10 | 11 | 12 |
| Flange diameter | 1370 | 1475 | 1615 | 1725 | 1100 | 1900 |
| Barrel diameter | 600 | 600 | 685 | 710 | 750 | 1500 |
| Traverse | 710 | 710 | 812 | 812 | 600 | 600 |
| Flange thickness | $2 \times 32$ | $2 \times 32$ | $2 \times 33$ | $2 \times 33$ | $2 \times 32$ | $2 \times 33$ |
| Bore Diameter | 80 | 80 | 100 | 100 | $54 \times 54$ | $105 \times 105$ |
| Nail Circle | 5 | 5 | 6 | 6 | 5 | 5 |
| Nail length | 75 | 75 | 89 | 89 | 75 | 75 |
| Nail Size(Min.) | 3.25 | 3.25 | 3.65 | 3.65 | 3.25 | 3.25 |
| Thickness of barrel end supports | 50 | 50 | 50 | 50 | 38 | 50 |
| Thickness of barrel end lagging | 38 | 50 | 50 | 50 | 38 | 50 |
| No. of stretchers | 6 | 6 | 6 | 6 | 4 | 4 |
| Stretchers sizes | $100 \times 33$ | $100 \times 50$ | $100 \times 50$ | $100 \times 50$ | $75 \times 50$ | $75 \times 75$ |
| No. of bolts | 6 | 6 | 6 | 6 | 4 | 4 |
| Diameter of bolt (Min.) | 12 | 19 | 19 | 19 | 19 | 22 |
| Size of square washer | $50 \times 6$ | $50 \times 6$ | $50 \times 63$ | $50 \times 6$ | $75 \times 6$ | $100 \times 6$ |
| Size of spindle plate | $230 \times 230 \times 6$ | $230 \times 230 \times 6$ | $230 \times 230 \times 6$ | $230 \times 230 \times 6$ | $230 \times 230 \times 6$ | $380 \times 380 \times 6$ |
| Diameter of spindle plate hole | 90 | 90 | 90 | 90 | - | - |
| No. of spindle plate bolt | 4 | 4 | 4 | 4 | 4 | 4 |
| Spindle plate bolt diameter | 12 | 12 | 12 | 12 | 16 | 16 |
| Thickness of external lagging | 38 | 50 | 50 | 50 | 38 | 50 |
| No. of binders over external lagging | 3 | 3 | 3 | 3 | 2 | 3 |



Section XX

Fig. 2 Drum having 3 ply flange construction with barrel middle supports.

## VARIOUS INTERNATIONAL STANDARDS

## ALL ALUMINIUM STANDARD CONDUCTORS - BARE (TO BS: 215 PART 1)

| Code Word | Aluminium Area $\mathrm{mm}^{2}$ | Standard <br> Nominal Copper Area/mm ${ }^{2}$ | Standing Number \& Diameter Of Wires mm |  | Diameter of Conductor mm | Rated Ultimate Strength Kg . | D-C <br> Resistance <br> at $20^{\circ} \mathrm{C}$ <br> $\Omega / \mathrm{Km}$. | Weight $\mathrm{Kg} / \mathrm{Km}$. |
| :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: |
|  |  |  | No. | Diameter |  |  |  |  |
| Midge | 23.29 | 14.19 | 7 | 2.06 | 6.17 | 430 | 1.22700 | 63.5 |
| Aphis | 26.45 | 16.13 | 3 | 3.35 | 7.21 | 445 | 1.08100 | 72.5 |
| Gnat | 26.84 | 16.13 | 7 | 2.21 | 6.63 | 490 | 1.06400 | 73.4 |
| Weevil | 31.55 | 19.35 | 3 | 3.66 | 7.87 | 520 | 0.90780 | 86.3 |
| Mosquito | 36.90 | 22.58 | 7 | 2.59 | 7.77 | 645 | 0.77420 | 100.9 |
| Ladybird | 42.90 | 25.81 | 7 | 2.79 | 8.38 | 740 | 0.66550 | 117.3 |
| Ant | 52.77 | 32.26 | 7 | 3.1 | 9.3 | 890 | 0.54110 | 144.3 |
| Fly | 63.68 | 38.71 | 7 | 3.4 | 10.21 | 1050 | 0.44860 | 174.0 |
| Bluebottle | 73.55 | 45.16 | 7 | 3.66 | 10.97 | 1195 | 0.38840 | 201.0 |
| Earwig | 78.77 | 48.39 | 7 | 3.78 | 11.37 | 1275 | 0.36280 | 215.3 |
| Grasshopper | 84.13 | 51.61 | 7 | 3.91 | 11.73 | 1355 | 0.33950 | 229.9 |
| Clegg | 95.35 | 58.06 | 7 | 4.17 | 12.50 | 1520 | 0.29950 | 260.7 |
| Wasp | 106.2 | 64.52 | 7 | 4.39 | 13.18 | 1675 | 0.26910 | 290.0 |
| Beetle | 106.10 | 64.52 | 19 | 2.67 | 13.33 | 1810 | 0.27050 | 292.0 |
| Bee | 132.10 | 80.64 | 7 | 4.90 | 14.71 | 2060 | 0.21620 | 362.0 |
| Cricket | 157.90 | 96.77 | 7 | 5.36 | 16.08 | 2450 | 0.18090 | 432.0 |
| Hornet | 157.70 | 96.77 | 19 | 3.25 | 16.26 | 2575 | 0.18210 | 433.0 |
| Caterpillar | 185.90 | 112.90 | 19 | 3.53 | 17.65 | 2985 | 0.15440 | 510.0 |
| Chafer | 213.80 | 129.00 | 19 | 3.78 | 18.92 | 3390 | 0.13430 | 588.0 |
| Spider | 237.30 | 145.20 | 19 | 3.99 | 19.94 | 3735 | 0.12100 | 652.0 |
| Cockroach | 265.30 | 161.30 | 19 | 4.22 | 21.08 | 4135 | 0.10820 | 729.0 |
| Buttertly | 322.40 | 193.50 | 19 | 4.65 | 23.24 | 4940 | 0.08910 | 885.0 |
| Moth | 373.60 | 225.80 | 19 | 5.00 | 25.02 | 5700 | 0.07686 | 1027.0 |
| Drone | 372.60 | 225.80 | 37 | 3.58 | 25.07 | 5730 | 0.07748 | 1030.0 |
| Locust | 428.60 | 258.10 | 19 | 5.36 | 26.80 | 6515 | 0.06698 | 1177.0 |
| Centipede | 416.30 | 258.10 | 37 | 3.78 | 26.49 | 6325 | 0.06941 | 1150.0 |
| Maybug | 486.00 | 290.30 | 37 | 4.09 | 28.63 | 7290 | 0.05943 | 1342.0 |
| Scorpion | 529.00 | 322.60 | 37 | 4.27 | 29.87 | 7870 | 0.05459 | 1463.0 |
| Cicada | 627.80 | 387.10 | 37 | 4.65 | 32.54 | 9210 | 0.04601 | 1735.0 |
| Tarantula | 795.60 | 483.90 | 37 | 5.23 | 36.63 | 11570 | 0.03630 | 2198.0 |

## ALL ALUMINIUM CONDUCTORS - BARE (AMERICAN SIZES)

| Code Name | Equivalent Copper size |  | Aluminium stranding No. and diameter |  | Dia. of complete Cable mm | Aluminium area of complete cable |  | Approx. ultimate Tensile Strength Kg | Standard Resistance at $20^{\circ} \mathrm{C}$ | Wt in $\mathrm{Kg} / \mathrm{km}$. |
| :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: |
|  | AWG | Nominal area $\mathrm{mm}^{2}$ | No. | Dia. <br> mm. |  | Gauge AWG | $\mathrm{mm}^{2}$ |  | $\Omega / \mathrm{Km}$. |  |
| Rose | 6 | 13.3 | 7 | 1.961 | 5.883 | 4 | 21.15 | 415 | 1.351 | 57.7 |
| Lily | 5 | 16.77 | 7 | 2.202 | 6.606 | 3 | 26.67 | 515 | 1.072 | 72.8 |
| Iris | 4 | 21.15 | 7 | 2.474 | 7.442 | 2 | 33.62 | 635 | 0.85 | 91.8 |
| Pansy | 3 | 26.67 | 7 | 2.776 | 8.328 | 1 | 42.41 | 775 | 0.674 | 115.8 |
| Poppy | 2 | 33.62 | 7 | 3.119 | 9.357 | 1/0 | 53.49 | 940 | 0.534 | 146.1 |
| Aster | 1 | 42.41 | 7 | 3.503 | 10.509 | 2/0 | 67.43 | 1185 | 0.424 | 184.2 |
| Phlox | 1/0 | 53.49 | 7 | 3.932 | 11.796 | 3/0 | 85.01 | 1435 | 0.336 | 232.3 |
| Oxlip | $2 / 0$ | 67.43 | 7 | 4.417 | 13.251 | 4/0 | 107.20 | 1810 | 0.267 | 292.9 |
| Daisy | 3/0 | 85.01 | 7 | 4.958 | 14.874 | 266,800 | 135.20 | 2280 | 0.211 | 369.2 |
| Peony | 188,800 | 95.60 | 19 | 3.193 | 15.965 | 300,000 | 152.00 | 2670 | 0.189 | 417.4 |
| Tulip | 4/00 | 107.20 | 19 | 3.381 | 16.905 | 336,400 | 170.50 | 2995 | 0.168 | 467.3 |
| Canna | 250,000 | 126.70 | 19 | 3.673 | 18.365 | 397,500 | 201.40 | 3470 | 0.142 | 553.0 |

## ALUMINIUM CONDUCTOR STEEL REINFORCED - BARE (AMERICAN SIZE)

| Code Word | Aluminium Area |  | Area of Complete Conductor $\mathrm{mm}^{2}$ | Copper Equivalent $\mathrm{mm}^{2}$ | Standing No. and Dia. Of Wires mm. |  |  |  | Diameter mm |  | Rated Ultimate Tensile Strength (kg) | $\begin{aligned} & \text { D-C } \\ & \text { Resistance } \\ & \text { at } 20^{\circ} \mathrm{C} \\ & (\Omega / \mathrm{km}) \end{aligned}$ | Weight kg/km |  |  |
| :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: |
|  |  |  | Aluminium |  | Steel |  |  |  |  |  |  |  |  |
|  | Circular Mils | $\mathrm{mm}^{2}$ |  |  | No. | Dia | No. | Dia. | Complete Conductor | Steel Core |  |  | Total | Alum. | Steel |
| Chickadee | 397500 | 201.42 |  | 212.58 | 126.68 | 18 | 3.77 | 1 | 3.77 | 18.87 | 3.77 | 4717 | 0.14270 | 641.5 | 554.4 | 87.1 |
| Pelican | 477000 | 241.68 | 255.10 | 152.01 | 18 | 4.14 | 1 | 4.14 | 20.68 | 4.14 | 5579 | 0.11890 | 770.9 | 666.3 | 104.6 |
| Flicker | 477000 | 241.68 | 273.03 | 152.01 | 24 | 3.58 | 7 | 2.39 | 21.48 | 7.16 | 7802 | 0.11950 | 914.1 | 669.7 | 244.4 |
| Osprey | 556500 | 282.00 | 297.68 | 177.35 | 18 | 4.47 | 1 | 4.47 | 22.33 | 4.47 | 6509 | 0.10180 | 898.8 | 776.8 | 122.0 |
| Parakeet | 556500 | 282.00 | 318.52 | 177.35 | 24 | 3.87 | 7 | 2.58 | 23.22 | 7.75 | 9004 | 0.10250 | 1066.8 | 7813 | 285.5 |
| Peacock | 605000 | 306.58 | 346.39 | 192.80 | 24 | 4.03 | 7 | 2.69 | 24.21 | 8.08 | 9798 | 0.09420 | 1159.2 | 849.8 | 309.5 |
| Squab | 605000 | 306.58 | 356.45 | 192.80 | 26 | 3.87 | 7 | 3.01 | 24.54 | 9.40 | 10954 | 0.09420 | 1267.8 | 849.8 | 389.8 |
| Teal | 605000 | 306.58 | 376.45 | 192.80 | 30 | 3.61 | 19 | 2.16 | 25.25 | 10.82 | 13630 | 0.09432 | 1397.4 | 851.2 | 546.2 |
| Rook | 636000 | 322.26 | 364.00 | 202.68 | 24 | 4.14 | 7 | 2.76 | 24.82 | 8.28 | 10274 | 0.08966 | 1218.7 | 892.9 | 325.8 |
| Flamingo | 666600 | 337.74 | 381.55 | 212.31 | 24 | 4.23 | 7 | 2.82 | 25.40 | 8.46 | 10773 | 0.08550 | 1277 | 936.0 | 341.0 |
| Tern | 795000 | 402.84 | 430.71 | 253.35 | 45 | 3.38 | 7 | 2.25 | 27.00 | 6.76 | 10410 | 0.07177 | 1333 | 1116.0 | 17.0 |
| Rail | 954000 | 483.42 | 516.84 | 304.03 | 45 | 3.70 | 7 | 2.47 | 29.59 | 7.39 | 12202 | 0.05981 | 1600 | 1339.0 | 216.0 |
| Ortlan | 1033500 | 523.68 | 559.93 | 32.36 | 45 | 3.85 | 7 | 2.57 | 30.81 | 7.70 | 13041 | 0.05522 | 1734 | 1451.0 | 283.0 |
| Bluejay | 111300 | 563.93 | 602.97 | 354.70 | 45 | 4.00 | 7 | 2.66 | 31.98 | 8.00 | 14039 | 0.05127 | 1875 | 1570.0 | 305.0 |
| Bunting | 1192500 | 604.26 | 646.00 | 380.03 | 45 | 4.14 | 7 | 2.76 | 33.07 | 8.28 | 15059 | 0.04785 | 2007 | 1681.0 | 326.0 |
| Bittern | 1272000 | 644.51 | 689,10 | 405.37 | 45 | 4.27 | 7 | 2.85 | 34.16 | 8.53 | 16057 | 0.04486 | 2143 | 1795.0 | 348.0 |
| Dipper | 1351500 | 685.16 | 732.26 | 430.70 | 45 | 4.40 | 7 | 2.92 | 35.18 | 8.76 | 17010 | 0.04222 | 2275 | 1906.0 | 369.0 |
| Bobolink | 1431000 | 725.16 | 775.48 | 456.04 | 45 | 4.53 | 7 | 3.02 | 36.25 | 9.07 | 18053 | 0.03988 | 2411 | 2019.0 | 392.0 |
| Nuthatch | 1510500 | 765.16 | 818.06 | 481.37 | 45 | 4.65 | 7 | 3,10 | 37.21 | 9.30 | 18869 | 0.03988 | 2543 | 2131.0 | 412.0 |
| Lapwing | 1590000 | 805.80 | 861.29 | 506.71 | 45 | 4.77 | 7 | 3.18 | 38.15 | 9.55 | 19867 | 0.03589 | 2677 | 2243.0 | 434.0 |
| Chukar | 1780000 | 901.93 | 975.48 | 567.00 | 84 | 3.70 | 19 | 2.22 | 40.69 | 11.10 | 24312 | 0.03212 | 3086 | 2510.0 | 576.0 |

## ALUMINIUM CONDUCTORS -BARE (CANADIAN STANDARD SIZES)

| Code word | Aluminium Area |  | Copper equivalent $\mathrm{mm}^{2}$ | Stranding, Number and diameter of wires (mm) |  | Dia. of conductor mm. | Rated ultimate strength Kg . | $\begin{gathered} \mathrm{D}-\mathrm{C} \\ \text { resistance } \\ 20^{\circ} \mathrm{C} \\ \hline \end{gathered}$ | Weight <br> $\mathrm{Kg} . / \mathrm{Km}$ |
| :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: |
|  | AWG of circular Mills | $\mathrm{mm}^{2}$ |  |  |  | $\Omega / \mathrm{Km}$. |  |  |
|  |  |  |  | No. | Dia. |  |  |  |  |
| Rose | 4 | 21.15 | 13.3 | 7 | 1.961 |  | 5.89 | 415 | 1.3510 | 57.7 |
| Lily | 3 | 26.67 | 16.77 | 7 | 2.202 | 6.60 | 515 | 1.0720 | 72.8 |
| Iris | 2 | 33.62 | 21.15 | 7 | 2.474 | 7.42 | 635 | 0.8500 | 91.8 |
| Pansy | 1 | 42.41 | 26.67 | 7 | 2.776 | 8.34 | 775 | 0.6740 | 115.8 |
| Poppy | 1/0 | 53.49 | 33.62 | 7 | 3.119 | 9.36 | 940 | 0.5340 | 146.1 |
| Aster | $2 / 0$ | 67.43 | 42.41 | 7 | 3.503 | 10.55 | 1185 | 0.4240 | 184.2 |
| Phlox | 3/0 | 85.01 | 53.49 | 7 | 3.932 | 11.79 | 1435 | 0.3360 | 232.3 |
| Oxlip | 4/0 | 107.20 | 67.43 | 7 | 4.417 | 13.26 | 1810 | 0.2670 | 292.9 |
| Daisy | 266,800 | 135.20 | 85.01 | 7 | 4.958 | 14.88 | 2280 | 0.2110 | 369.2 |
| Peony | 300,000 | 152.00 | 95.60 | 19 | 3.193 | 15.98 | 2670 | 0.1890 | 417.4 |
| Tulip | 396,400 | 170.50 | 107.20 | 19 | 3.381 | 16.92 | 2995 | 0.1680 | 467.3 |
| Canaa | 397,500 | 201.40 | 126.70 | 19 | 3.673 | 18.36 | 3470 | 0.1420 | 553.0 |
| Cosmos | 477,000 | 241.70 | 152.00 | 19 | 4.023 | 20.12 | 4080 | 0.1190 | 663.5 |
| Zinnia | 500,000 | 253.30 | 159.40 | 19 | 4.120 | 20.60 | 4275 | 0.1130 | 695.6 |
| Dahlia | 556,500 | 282.00 | 177.40 | 19 | 4.346 | 21.75 | 4760 | 0.1020 | 774.2 |
| Orchid | 636,000 | 322.30 | 202.70 | 37 | 3.330 | 23.31 | 5665 | 0.0895 | 888.9 |
| Violet | 715,500 | 362.50 | 228.00 | 37 | 3.533 | 24.71 | 6375 | 0.0795 | 1000.0 |
| Petunia | 750,000 | 380.00 | 239.00 | 37 | 3.617 | 25.32 | 6545 | 0.0758 | 1048.0 |
| Arbutus | 795,000 | 402.80 | 253.40 | 37 | 3.724 | 26.04 | 6940 | 0.0715 | 1111.0 |
| Anemone | 874,500 | 443.10 | 278.70 | 37 | 3.904 | 27.33 | 7475 | 0.0652 | 1222.0 |
| Magnolia | 954,000 | 483.40 | 304.00 | 37 | 4.079 | 28.56 | 8155 | 0.0597 | 1333.0 |
| Bluebell | 1,033,500 | 523.70 | 329.40 | 37 | 4.244 | 29.75 | 8835 | 0.0551 | 1445.0 |
| Marigold | 1,113,000 | 564.00 | 354.70 | 61 | 3.432 | 30.87 | 9910 | 0.0513 | 1560.0 |
| Hawthom | 1,192,500 | 604.20 | 380.00 | 61 | 3.551 | 31.95 | 10615 | 0.0478 | 1670.0 |
| Narcissus | 1,272,000 | 644.50 | 405.40 | 61 | 3.668 | 33.02 | 11090 | 0.0449 | 1781.0 |
| Columbine | 1,351,500 | 684.80 | 430.70 | 61 | 3.780 | 34.01 | 11795 | 0.0423 | 1893.0 |
| Carnation | 1,431,000 | 725.10 | 456.00 | 61 | 3.891 | 35.03 | 12225 | 0.0399 | 2005.0 |
| Gladiolus | 1,510,500 | 765.40 | 481.40 | 61 | 3.998 | 36.00 | 12905 | 0.0378 | 2116.0 |
| Coreopsis | 1,590,000 | 805.70 | 506.70 | 61 | 4.100 | 36.91 | 13585 | 0.0359 | 2226.0 |

## ALUMINIUM CONDUCTOR STEEL REINFORCED (CANADIAN STANDARD SIZES)

| Code word | Aluminium Area |  | Area of Complete conductor $\mathrm{mm}^{2}$ | Copper equivalent $\mathrm{mm}^{2}$ | Stranding No. \& diameter of wires mm |  | Diameter mm |  | Rated Ultimate Tensile Strength kg. | D-C <br> Resistance at $20^{\circ} \mathrm{C}$ ohms per km | Weight kg per km . |  |  |
| :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: |
|  |  |  |  |  |  |  |  |  |  |  |  |  |  |
|  | Mils | mm ${ }^{2}$ |  |  | Aluminium | Steel | nductor | Core |  |  | Total | Aluminium | Steel |
| Wren | 8 | 8.37 | 9.81 | 5.26 | 6/1.33 | 1/1.33 | 3.99 | 1.33 | 340 | 3.423 | 33.77 | 22.89 | 10.88 |
| Warbler | 7 | 10.55 | 12.34 | 6.63 | 6/1.50 | 1/1.50 | 4.5 | 1.5 | 425 | 2.714 | 42.53 | 28.86 | 13.68 |
| Turkey | 6 | 13.3 | 15.46 | 8.37 | 6/1.68 | 1/1.68 | 5.04 | 1.68 | 530 | 2.154 | 53.61 | 36.39 | 17.22 |
| Thrush | 5 | 16.77 | 19.55 | 10.55 | 6/1.89 | 1/1.89 | 5.67 | 1.89 | 660 | 1.707 | 67.64 | 45.88 | 21.76 |
| Swan | 4 | 21.15 | 24.75 | 13.3 | 6.2.12 | 1/2.12 | 6.36 | 2.12 | 830 | 1.354 | 85.31 | 57.89 | 27.42 |
| Swallow | 3 | 26.67 | 31.1 | 16.77 | 6/2.38 | 1/2.38 | 7.14 | 2.38 | 1025 | 1.074 | 107.6 | 72.97 | 34.61 |
| Sparrow | 2 | 33.62 | 39.22 | 21.15 | 6/2.67 | 1/2.67 | 8.01 | 2.67 | 1265 | 0.8507 | 135.6 | 92.02 | 43.63 |
| Robin | 1 | 42.41 | 49.48 | 26.67 | 6/3.00 | 1/3.00 | 9 | 3 | 1585 | 0.6754 | 171.1 | 116.1 | 55 |
| Raven | 36526 | 53.49 | 62.38 | 33.62 | 6/3.37 | 1/3.37 | 10.11 | 3.37 | 1940 | 0.5351 | 215.9 | 146.5 | 69.4 |
| Quail | 36557 | 67.43 | 78.64 | 42.41 | 6/3.78 | 1/3.78 | 11.34 | 3.78 | 2425 | 0.4245 | 272.1 | 184.6 | 87.5 |
| Pigeon | 36617 | 85.01 | 99.23 | 53.49 | 6/4.25 | 1/4.25 | 12.75 | 4.25 | 3030 | 0.3367 | 342.9 | 232.7 | 110.2 |
| Penguin | 266800 | 107.2 | 125.1 | 67.43 | 6/4.77 | 1/4.77 | 14.31 | 4.77 | 3820 | 0.2671 | 432.5 | 293.5 | 139 |
| Partridge | 266800 | 135.2 | 157.2 | 85.01 | 26/2.57 | 7/2.00 | 16.28 | 6 | 5100 | 0.2137 | 545.4 | 373.5 | 171.9 |
| Owl | 266800 | 135.2 | 152.7 | 85.01 | 6/5.36 | 7/1.79 | 16.09 | 5.37 | 4330 | 0.2118 | 506.8 | 370.1 | 136.7 |
| Waxwing | 300000 | 135.2 | 142.6 | 85.01 | 18/3.09 | 1/3.09 | 15.47 | 3.09 | 3210 | 0.2126 | 429.8 | 371.5 | 583.4 |
| Piper | 300000 | 152 | 187.5 | 95.60 | 30/2.54 | 7/2.54 | 17.78 | 7.62 | 7000 | 0.1902 | 697 | 420.2 | 276.8 |
| Ostrich | 336400 | 152 | 176.7 | 95.60 | 26/2.73 | 7/2.12 | 17.28 | 6.36 | 5730 | 0.19 | 612.7 | 419.7 | 193 |
| Oriole | 336400 | 170.5 | 210.3 | 107.20 | 30/2.69 | 7/2.69 | 18.83 | 8.07 | 7735 | 0.1696 | 781.6 | 471.3 | 310.3 |
| Linnet | 336400 | 170.5 | 198.3 | 107.20 | 26/2.89 | 7/2.25 | 18.31 | 6.75 | 6375 | 0.1694 | 687.4 | 470.7 | 216.7 |
| Merlin | 336400 | 170.5 | 179.9 | 107.20 | 18/3.47 | 1/3.47 | 17.37 | 3.47 | 4060 | 0.1686 | 542 | 468.4 | 73.6 |
| Lark | 397500 | 201.4 | 248.4 | 126.70 | 30/2.92 | 7/2.92 | 20.44 | 8.76 | 9060 | 0.1435 | 923.3 | 556.6 | 366.7 |
| Ibis | 397500 | 201.4 | 234.2 | 126.70 | 26/3.14 | 7/2.44 | 19.88 | 7.32 | 7340 | 0.1434 | 811.7 | 556.1 | 255.6 |
| Hen | 477000 | 241.7 | 298.1 | 152.00 | 30/3.20 | 7/3.20 | 22.4 | 9.6 | 10590 | 0.1196 | 1108 | 668 | 440 |
| Hawk | 477000 | 241.7 | 281.1 | 152.00 | 26/3.44 | 7/2.68 | 21.8 | 8.04 | 8820 | 0.1195 | 974.9 | 667.4 | 307.5 |
| Heron | 500000 | 253.3 | 312.4 | 159.40 | 30/3.28 | 7/3.28 | 22.96 | 9.84 | 11090 | 0.1141 | 1162 | 701 | 461 |
| Eagle | 556500 | 282 | 347.8 | 177.40 | 30/3.460 | 7/3.460 | 24.22 | 10.38 | 12360 | 0.1025 | 1293 | 779 | 514 |
| Dove | 556500 | 282 | 327.9 | 177.40 | 26/3.720 | 7/2.890 | 23.55 | 8.67 | 10190 | 0.1025 | 1137 | 779 | 358 |
| Duck. . | 605000 | 306.6 | 346.4 | 192.80 | 54/3.690 | 7/2.690 | 24.21 | 8.07 | 10210 | 0.09439 | 1158 | 848 | 310 |
| Egret | 636000 | 322.3 | 395.6 | 202.70 | 30/3.700 | 19/2.220 | 25.9 | 11.1 | 14330 | 0.08973 | 1466 | 891 | 575 |
| Grosbeak | 636000 | 322.3 | 374.7 | 202.70 | 26/3.970 | 7/3.090 | 25.15 | 9.27 | 11340 | 0.08966 | 1299 | 890 | 409 |
| Goose | 636000 | 322.3 | 364 | 202.70 | 54/2.760 | 7/2.760 | 24.81 | 8.27 | 10730 | 0.08979 | 1218 | 892 | 326 |
| Gull | 666600 | 337.8 | 381.5 | 212.30 | 54/2.820 | 7/2.820 | 25.38 | 8.47 | 11140 | 0.08569 | 1276 | 935 | 341 |
| Redwing | 715500 | 362.5 | 445.1 | 228.00 | 30/3.920 | 19/2.350 | 27.43 | 11.76 | 15690 | 0.07978 | 1648 | 1002 | 646 |
| Staring | 715500 | 362.5 | 421.6 | 228.00 | 26/4.210 | 7/3.280 | 26.68 | 9.83 | 12750 | 0.07966 | 1462 | 1001 | 164 |
| Crow | 715500 | 362.5 | 409.5 | 228.00 | 54/2.920 | 7/2.920 | 26.28 | 8.77 | 11950 | 0.07985 | 1370 | 1003 | 367 |
| Mallard | 795000 | 402.8 | 494.7 | 253.40 | 30/4.140 | 19/2.480 | 28.96 | 12.41 | 17440 | 0.07177 | 1833 | 1144 | 719 |
| Drake | 795000 | 402.8 | 468.5 | 253.40 | 26/4.442 | 7/3.454 | 28.14 | 10.36 | 14175 | 0.07171 | 1624 | 1113 | 512 |
| Condor | 795000 | 402.8 | 455.1 | 253.40 | 54/3.084 | 7/3.084 | 26.76 | 9.25 | 12950 | 0.07183 | 1522 | 1114 | 408 |
| Crane | 874500 | 443.1 | 500.6 | 278.70 | 54/3.233 | 7/3.233 | 29.11 | 9.7 | 14245 | 0.06531 | 1674 | 1226 | 448 |
| Canary | 900000 | 456.1 | 515.2 | 286.80 | 54/3.279 | 7/3.279 | 29.51 | 9.84 | 14650 | 0.06344 | 1723 | 1262 | 461 |
| Cardinal | 954000 | 483.4 | 546.1 | 304.00 | 54/3.376 | 7/3.376 | 30.38 | 10.13 | 15535 | 0.05988 | 1826 | 1337 | 489 |
| Curlew. | 1033500 | 523.7 | 291.6 | 329.40 | 54/3.515 | 7/3.515 | 31.65 | 10.55 | 16850 | 0.05527 | 1979 | 1449 | 530 |
| Finch | 111300 | 563.9 | 635.5 | 354.70 | 51/3.647 | 19/2.189 | 32.84 | 10.95 | 18238 | 0.05133 | 2120 | 1560 | 560 |
| Grackel | 1192500 | 604.3 | 680.8 | 380.00 | 54/3.774 | 19/2.266 | 33.99 | 11.33 | 19550 | 0.0479 | 2271 | 1672 | 590 |
| Pheasant | 1272000 | 644.5 | 726.2 | 405.40 | 54/3.900 | 19/2.339 | 35.36 | 11.7 | 20320 | 0.0449 | 2422 | 1783 | 639 |
| Martin | 1351500 | 684.8 | 771.5 | 430.70 | 54/4.018 | 19/2.410 | 36.17 | 12.05 | 21590 | 0.04227 | 2574 | 1895 | 679 |
| Plover | 1431000 | 725.1 | 817 | 456.00 | 54/4.135 | 19/2.482 | 37.21 | 12.41 | 22860 | 0.03992 | 2275 | 2006 | 719 |
| Parrot | 1510500 | 765.4 | 862.4 | 481.40 | 54/4.249 | 19/2.550 | 38.25 | 12.75 | 24175 | 0.03782 | 2877 | 2118 | 759 |
| Falcon | 1590000 | 805.7 | 907.8 | 506.70 | 54/4.359 | 19/2.616 | 39.24 | 13.08 | 25445 | 0.03592 | 3028 | 2229 | 799 |


| Code word |  | Standing \& wire diameter |  | Area of Alu. | Area of complete conductor | Diameter of |  | Resistance at $20^{\circ} \mathrm{C}$ | Approx. Ultimate strength of contd. | Approximately weight of conductor |  |  | $\begin{gathered} \mathrm{Km} / \\ \mathrm{kg} \end{gathered}$ | Standard length of drum | Approximately Net weight of conductor drum |  |
| :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: |
|  |  |  |  | Complete conductor |  | Steel core |  |  |  |  |  |  |  |  |  |
|  |  | Alu. | Steel |  |  |  | Alu. |  |  | Steel | Total | Ungreased |  |  | Greased |
|  | $\mathrm{mm}^{2}$ | mm | mm | $\mathrm{mm}^{2}$ | $\mathrm{mm}^{2}$ |  |  | $\Omega / \mathrm{km}$ | kg | kg . | kg . | kg . |  | m | kg | kg |
| Calibri | 10 | 6/1.84 | 1/1.84 | 15.95 | 18.61 | 5.52 | 1.84 | 1.808 | 610.5 | 43.7 | 20.9 | 64.6 | 0.8 | $2 \times 4247$ | 548 | 555 |
| Randine | 16 | 5/2.32 | 1/2.32 | 25.35 | 29.58 | 6.96 | 2.32 | 1.137 | 920.8 | 69.3 | 23 | 102.3 | 1.2 | $2 \times 2671$ | 548 | 555 |
| Fringuelio | 25 | 6/2.90 | 1/2.90 | 39.64 | 46.25 | 8.70 | 2.9 | 0.727 | 1408 | 108 | 52 | 160 | 2 | $2 \times 1707$ | 548 | 555 |
| Carvo | 35 | 6/3.44 | 1/3.44 | 55.74 | 65.03 | 10.32 | 3.44 | 0.517 | 1956 | 152 | 73 | 225 | 2.7 | 2428 | 548 | 555 |
| Gufo | 35 | 26/1.65 | 7/1.28 | 55.69 | 64.72 | 10.44 | 3.84 | 0.524 | 2114 | 154 | 71 | 225 | 4.4 | $2 \times 4556$ | 2053 | 2093 |
| Merlo | 35 | 30/1.54 | 7/1.54 | 55.74 | 68.75 | 10.78 | 4.62 | 0.522 | 2608 | 155 | 102 | 257 | 5.8 | $2 \times 3301$ | 1561 | 1595 |
| Quaglia | 50 | 6/4.11 | 1/4.11 | 79.59 | 92.85 | 12.33 | 4.11 | 0.362 | 2771 | 218 | 104 | 322 | 3.9 | 1701 | 548 | 555 |
| Fragrance | 50 | 6/4.11 | 7/1.37 | 79.59 | 89.83 | 12.33 | 4.11 | 0.362 | 2503 | 218 | 81 | 299 | 6.7 | 1715 | 513 | 524 |
| Colombo | 50 | 26/1.97 | 7/1.53 | 79.17 | 92.04 | 12.47 | 4.59 | 0.368 | 2971 | 219 | 101 | 320 | 6.2 | $2 \times 3208$ | 2053 | 2093 |
| Cíncia | 50 | 30/1.84 | 7/1.84 | 79.74 | 98.25 | 12.88 | 5.52 | 0.356 | 3694 | 221 | 147 | 368 | 8.3 | $2 \times 2123$ | 1561 | 1596 |
| Canario | 70 | 6/4.85 | 1/4.85 | 111.25 | 129.79 | 14.58 | 4.85 | 0.26 | 3873 | 305 | 145 | 450 | 5.4 | 1217 | 548 | 555 |
| Sparviero | 70 | 6/4.85 | 7/1.62 | 111.25 | 125.7 | 14.58 | 4.86 | 0.26 | 3504 | 305 | 114 | 419 | 9.3 | 1226 | 513 | 524 |
| Pemice | 70 | 26/2.33 | 7/1.81 | 110.90 | 128.73 | 14.75 | 5.43 | 0.263 | 4091 | 307 | 142 | 449 | 8.7 | $2 \times 2265$ | 2053 | 2093 |
| Civetta | 70 | 30/2.17 | 7/2.17 | 110.71 | 136.78 | 15.19 | 6.51 | 0.263 | 4890 | 307 | 204 | 511 | 12 | 3053 | 1561 | 1596 |
| struzzo | 95 | 26/2.72 | 7/2.12 | 151.14 | 175.88 | 17.24 | 6.36 | 0.193 | 5348 | 419 | 195 | 614 | 12 | 3343 | 2053 | 2093 |
| Gru | 95 | 30/2.53 | 7/2.53 | 150.77 | 185.95 | 17.71 | 7.59 | 0.193 | 6563 | 417 | 278 | 695 | 16 | 2245 | 1561 | 1595 |
| Zigolo | 120 | 26/3.06 | 7/2.38 | 191.23 | 222.39 | 19.38 | 7.14 | 0.152 | 6677 | 530 | 246 | 776 | 15 | 2646 | 2.053 | 2.093 |
| Ghiandaia | 120 | 30/285 | 7/2.85 | 191.42 | 235.03 | 19.95 | 8.55 | 0.152 | 8255 | 530 | 352 | 882 | 20 | 1768 | 1.561 | 1.595 |
| Rigogolo | 150 | 26/3.42 | 7/2.66 | 238.70 | 277.55 | 21.66 | 7.98 | 0.122 | 8474 | 661 | 307 | 968 | 19 | 2120 | 2.053 | 2093 |
| Fanello | 150 | 30/3.18 | 7/3.18 | 238.26 | 293.85 | 22.26 | 9.54 | 0.122 | 10206 | 660 | 439 | 1099 | 25 | 1420 | 156 | 1596 |
| Allodola | 185 | 26/3.80 | 7/2.95 | 294.89 | 343.03 | 24.08 | 8.88 | 0.0989 | 10170 | 817 | 380 | 1197 | 23 | 1715 | 2053 | 2093 |
| Usignuola | 185 | 30/3.53 | 7/3.53 | 293.61 | 352.12 | 24.71 | 10.59 | 0.0992 | 12501 | 813 | 541 | 1354 | 30 | 1152 | 1561 | 1596 |
| Picchio | 185 | 54/2.63 | 7/2.63 | 292.99 | 330.97 | 22.67 | 7.89 | 0.0995 | 9267 | 812 | 300 | 1112 | 17 | 2078 | 2312 | 2347 |
| Falcone | 240 | 26/4.32 | 7/3.35 | 381.11 | 443.21 | 27.36 | 10.08 | 0.0765 | 13109 | 1056 | 490 | 1546 | 30 | 1328 | 2053 | 2093 |
| Airone | 240 | 30/4.02 | 19/2.41 | 380.90 | 469.57 | 28.13 | 12.05 | 0.0733 | 15907 | 1030 | 689 | 1719 | 41 | 1236 | 2124 | 2175 |
| Gazza | 240 | 54/3.00 | 7/3.00 | 381.48 | 430.93 | 27.00 | 9 | 0.0764 | 11916 | 1057 | 390 | 1447 | 22 | 1597 | 2312 | 2346 |
| Storno | 300 | 54/3.35 | 7/3,35 | 475.95 | 537.59 | 30.15 | 10.05 | 0.0613 | 14724 | 1318 | 487 | 1805 | 27 | 1279 | 2312 | 2346 |
| Beccaccia | 400 | 54/3.87 | 19/2.32 | 634.76 | 715.05 | 34.82 | 11.6 | 0.0495 | 19241 | 1758 | 637 | 2395 | 37 | 891 | 2133 | 2165 |
| Aquila | 500 | 54/4.33 | 19/2.60 | 795.37 | 895.37 | 38.98 | 13 | 0.0367 | 24090 | 2203 | 802 | 3005 | 48 | 708 | 2124 | 2160 |

## ALUMINIUM CONDUCTOR STEEL REINFORCED - ACSR (BRITISH STANDARD SIZES)

BS 215 (PART - 2)

| Code <br> Word | Nom. Copper Area $\mathrm{mm}^{2}$ | Stranding \& wire diameter |  |  |  | Aluminium Area mm ${ }^{2}$ | Area Of Complete Conductor $\mathrm{mm}^{2}$ | Overall Diameter | Ultimate Tensile Strength Kgs. | Resistance at $20^{\circ} \mathrm{C} \Omega$ /Km | Weight Kg/Km |  |  |
| :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: |
|  |  | Aluminium |  | Steel |  |  |  |  |  |  |  |  |  |
|  |  | No. | mm | No. | mm |  |  |  |  |  | Total | Aluminium | Steel |
| Mole | 6.45 | 6 | 1.50 | 1 | 1.50 | 10.58 | 12.35 | 4.50 | 410 | 2.705 | 42.8 | 2.9 | 13.8 |
| Squirrel | 12.9 | 6 | 2.11 | 1 | 2.11 | 20.95 | 24.44 | 6.33 | 770 | 1.366 | 84.6 | 57.2 | 27.4 |
| Gopher | 16.13 | 6 | 2.36 | 1 | 2.36 | 26.30 | 30.68 | 7.08 | 955 | 1.089 | 106.0 | 71.9 | 34.1 |
| Weasel | 19.35 | 6 | 2.59 | 1 | 2.59 | 31.63 | 36.90 | 7.77 | 1135 | 0.9047 | 127.7 | 86.5 | 41.2 |
| Fox | 22.58 | 6 | 2.79 | 1 | 2.79 | 36.79 | 42.92 | 8.36 | 1310 | 0.778 | 148.5 | 100.6 | 47.9 |
| Farret | 25.81 | 6 | 3.00 | 1 | 3.00 | 42.35 | 49.41 | 9.00 | 1500 | 0.676 | 170.8 | 115.8 | 55.0 |
| Rabbit | 22.6 | 6 | 3.35 | 1 | 3.35 | 52.95 | 61.78 | 10.05 | 1860 | 0.5404 | 213.9 | 145.1 | 68.8 |
| Mink | 38.71 | 6 | 3.66 | 1 | 3.66 | 63.6 | 73.57 | 10.98 | 2205 | 0.054 | 254.8 | 172.8 | 82.0 |
| Skunk | 38.71 | 12 | 2.59 | 7 | 2.59 | 63.29 | 100.2 | 12.95 | 5270 | 0.457 | 464.5 | 174.7 | 289.8 |
| Beaver | 45.16 | 6 | 3.99 | 1 | 3.99 | 74.97 | 87.42 | 11.97 | 2615 | 0.382 | 302.7 | 205.2 | 97.5 |
| Hors | 45.16 | 12 | 2.79 | 7 | 2.79 | 73.55 | 116.51 | 13.97 | 6110 | 0.3929 | 540.3 | 203.2 | 337.1 |
| Racoon | 48.39 | 6 | 4.09 | 1 | 4.09 | 78.84 | 91.94 | 12.27 | 2745 | 0.3633 | 318.5 | 215.9 | 102.6 |
| Otter | 51.61 | 6 | 4.22 | 1 | 4.22 | 83.74 | 97.74 | 12.66 | 2915 | 0.3418 | 338.5 | 229.4 | 109.1 |
| Cat | 58.16 | 6 | 4.50 | 1 | 4.50 | 95.29 | 111.20 | 13.50 | 3315 | 0.3005 | 384.7 | 260.7 | 124.0 |
| Hare | 64.62 | 6 | 4.72 | 1 | 4.72 | 105.2 | 122.70 | 14.16 | 3660 | 0.2722 | 424.7 | 288.0 | 136.7 |
| Dog | 64.52 | 6 | 4.72 | 7 | 1.57 | 105.2 | 118.80 | 14.15 | 3310 | 0.2722 | 395.2 | 288.1 | 107.1 |
| Hyena | 64.52 | 7 | 4.39 | 7 | 1.33 | 106.2 | 126.60 | 14.57 | 4150 | 0.2697 | 451.5 | 296.6 | 160.9 |
| Leopard | 80.654 | 6 | 5.28 | 7 | 1.75 | 131.6 | 148.50 | 15.81 | 4120 | 0.2177 | 493.0 | 360.2 | 132.8 |
| Coyote | 80.65 | 26 | 2.54 | 7 | 1.91 | 131.7 | 151.70 | 115.18 | 4645 | 0.2198 | 521.7 | 365.0 | 156.7 |
| Tiger | 80.65 | 30 | 2.36 | 7 | 2.36 | 131.5 | 162.10 | 16.52 | 5790 | 0.2203 | 605.1 | 364.1 | 241.0 |
| Wolf | 96.77 | 30 | 2.59 | 7 | 2.59 | 158.1 | 195.00 | 18.13 | 6875 | 0.1831 | 727.7 | 43.8 | 28.7 |
| Lynx | 112.9 | 30 | 2.79 | 7 | 2.79 | 183.9 | 226.80 | 19.53 | 7945 | 0.1575 | 846.7 | 509.6 | 337.1 |
| Panther | 129 | 30 | 3.00 | 7 | 3.00 | 211.7 | 261.20 | 21.00 | 9095 | 0.1368 | 974.1 | 586.2 | 387.9 |
| Lion | 145.2 | 30 | 3.18 | 7 | 3.18 | 237.5 | 292.90 | 22.26 | 10160 | 0.1219 | 1093 | 657.8 | 435.2 |
| Boar | 161.3 | 30 | 3.35 | 7 | 3.37 | 264.8 | 326.60 | 23.50 | 11320 | 0.1093 | 1219.6 | 733.7 | 485.3 |
| Goat | 193.5 | 30 | 3.71 | 7 | 3.71 | 324.0 | 399.60 | 25.97 | 13765 | 0.08935 | 1491.3 | 897.7 | 593.6 |
| Sheep | 225.8 | 30 | 3.99 | 7 | 3.99 | 374.7 | 462.10 | 27.93 | 15900 | 0.0773 | 1725 | 1038 | 687.0 |
| Antelope | 225.8 | 54 | 2.97 | 7 | 2.97 | 374.5 | 423.10 | 26.73 | 11680 | 0.07736 | 1418 | 1037 | 381.0 |
| Bison | 225.8 | 54 | 3 | 7 | 3.00 | 380.2 | 430.50 | 26.97 | 11885 | 0.07606 | 1443 | 1055 | 388.0 |
| Deer | 258.1 | 30 | 4.27 | 7 | 4.27 | 429.1 | 529.20 | 29.89 | 18190 | 0.06748 | 1976 | 1189 | 787.0 |
| Zebra | 258.1 | 54 | 3.18 | 7 | 3.18 | 423.5 | 482.90 | 28.62 | 13245 | 0.06773 | 1619 | 1184 | 435.0 |
| Elk | 290.3 | 30 | 4.5 | 7 | 4.50 | 476.3 | 587.50 | 31.5 | 20185 | 0.06079 | 2192 | 1319 | 873.0 |
| Camel | 290.3 | 54 | 3.35 | 7 | 3.35 | 476.6 | 538.4 | 30.15 | 14740 | 0.06076 | 1805 | 1.32 | 485 |
| Moose | 322.6 | 54 | 3.53 | 7 | 3.35 | 528.5 | 597 | 31.77 | 16280 | 0.0548 | 2002 | 1464 | 538 |

Theoretical values valid upto 60 Hz for a wind velocity of $0.6 \mathrm{~m} / \mathrm{sec}$. and solar action for an initial temperature of $35^{\circ} \mathrm{C}$ and an ultimate cable temperature of $80^{\circ} \mathrm{C}$
In the case of unusual placement without air movement, these values will be reduced on an average of $90 \%$ approximately.

## DICABS

## ALUMINIUM CONDUCTOR STEEL REINFORCED - ACSR (CANADIAN STANDARD SIZES)

| Code word | Cross sectional area |  | Total | Copper area $\mathrm{mm}^{2}$ | Stranding and wire diameter |  | Overall diameter $\mathrm{mm}^{2}$ | Weight per km |  |  | \%wt |  | Ultimate <br> strength <br> of <br> conductor <br> Kgs | DC resistant at $20^{\circ} \mathrm{C}$ $\Omega / \mathrm{km}$ |
| :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: |
|  | Aluminium | Steel |  |  | Aluminium | Steel |  | Aluminium | Steel | Total | Aluminium |  |  |  |
|  | $\mathrm{mm}^{2}$ | $\mathrm{mm}^{2}$ |  |  | $\mathrm{No} / \mathrm{mm}$ | $\mathrm{No} / \mathrm{mm}$ |  | $\mathrm{Kg} / \mathrm{k}$ | $\mathrm{Kg} / \mathrm{k}$ | Kg/k | Aluminium |  |  |  |
| Wren | 8.37 | 1.44 | 9.81 | 5.26 | 6/1,33 | 1/1.33 | 3.99 | 22.89 | 10.88 | 33.77 | 67.9 | 32.1 | 340 | 3.423 |
| Warbler | 10.55 | 1.77 | 12.32 | 6.63 | 6/1.50 | 1/1.50 | 4.50 | 28.86 | 13.67 | 42.53 | 67.9 | 32.1 | 425 | 2.714 |
| Turkey | 13.3 | 2.16 | 15.46 | 8.37 | 6/1.68 | 1/1.68 | 5.04 | 36.39 | 17.22 | 53.61 | 67.9 | 32.1 | 530 | 2.154 |
| Thrush | 16.77 | 2.78 | 19.55 | 10.55 | 6/1.89 | 1/1.89 | 5.67 | 45.88 | 21.76 | 67.64 | 67.9 | 32.1 | 660 | 1.707 |
| Swan | 21.15 | 3.56 | 24.71 | 13.3 | 6/2.12 | 1/2.12 | 6.36 | 57.89 | 27.42 | 85.31 | 67.9 | 32.1 | 830 | 1.354 |
| Swallow | 26.67 | 4.43 | 31.1 | 16.77 | $6 / 2.38$ | 1/2.38 | 7.14 | 72.97 | 34.61 | 107.6 | 66.7 | 32.1 | 1025 | 1.074 |
| Sparrow | 32.62 | 5.6 | 39.22 | 21.15 | $6 / 2.67$ | 1/2.67 | 8.01 | 92.02 | 43.63 | 135.6 | 67.9 | 32.1 | 1265 | 0.8507 |
| Robin | 42.41 | 7.07 | 49.48 | 26.67 | $6 / 3.00$ | 1/3.00 | 9.00 | 116.1 | 55 | 171 | 67.9 | 32.1 | 1585 | 0.6754 |
| Raven | 53.49 | 8.89 | 62.38 | 36.62 | $6 / 3.37$ | 1/3.37 | 10.11 | 146.5 | 69.4 | 215.9 | 67.9 | 32.1 | 1940 | 0.5351 |
| Quill | 67.43 | 11.21 | 78.64 | 42.41 | 6/3.78 | 1/3.78 | 11.34 | 184.6 | 87.5 | 272.1 | 67.9 | 32.1 | 2425 | 0.4245 |
| Pigeon | 85.01 | 14.22 | 99.23 | 53.49 | $6 / 4.25$ | 1/4.25 | 12.75 | 232.7 | 110.2 | 342.9 | 67.9 | 32.1 | 3030 | 0.3367 |
| Penguin | 107.2 | 17.9 | 125.1 | 67.43 | 6/4.77 | 1/4.7 | 14.31 | 293.5 | 139 | 432.5 | 67.9 | 32.1 | 3820 | 0.2671 |
| Partridge | 135.2 | 22 | 157.2 | 85.01 | 26/2.57 | 7/2.00 | 16.28 | 373.5 | 171.9 | 545.4 | 68.5 | 31.5 | 5100 | 0.2137 |
| Owl | 135.2 | 17.5 | 152.7 | 85.01 | 6/5.36 | 7/1.79 | 16.09 | 370.1 | 136.7 | 506.8 | 73 | 27 | 4330 | 0.2118 |
| Waxwing | 135.2 | 7.4 | 142.6 | 85.01 | 18/3.09 | 1/3.09 | 15.47 | 371.5 | 583.4 | 429.8 | 86.4 | 13.6 | 3210 | 0.2126 |
| Piper | 152 | 35.5 | 187.5 | 95.6 | 30/2.54 | 7/2.54 | 17.78 | 420.2 | 276.8 | 697 | 60.3 | 39.7 | 7000 | 0.1902 |
| Ostrich | 152 | 24.7 | 176.7 | 95.6 | 26/2.73 | 7/2.12 | 17.28 | 419.7 | 193 | 612.7 | 68.5 | 31.5 | 5730 | 0.19 |
| Oriole | 170.5 | 39.8 | 210.3 | 107.2 | 30/2.69 | 7/2.69 | 18.83 | 471.3 | 310.3 | 781.3 | 60.3 | 39.7 | 7735 | 0.1696 |
| Linnet | 170.5 | 27.8 | 198.3 | 107.2 | 26/2.89 | 7/2.25 | 18.31 | 470.7 | 216.7 | 681.4 | 68.5 | 31.5 | 6375 | 0.1694 |
| Marlin | 170.5 | 9.4 | 179.9 | 107.2 | 18/3.47 | 1/3.47 | 17.37 | 468.4 | 73.6 | 542 | 86.4 | 13.6 | 4060 | 0.1686 |
| Chickadee | 201.4 | 11.2 | 212.6 | 126.7 | 18/3.77 | 1/3.77 | 18.87 | 554.4 | 87.7 | 641.5 | 86.4 | 13.6 | 4717 | 0.1427 |
| Lark | 201.4 | 47 | 248.4 | 126.7 | 3/2.92 | 7/2.92 | 20.44 | 556.6 | 366.7 | 923.3 | 60.3 | 39.7 | 9060 | 0.1435 |
| Lbis | 201.4 | 32.8 | 234.2 | 126.7 | 26/3.14 | 7/2.44 | 19.88 | 556.1 | 255.6 | 811.7 | 68.5 | 31.5 | 7340 | 0.1434 |
| Pelican | 241.7 | 13.4 | 255.1 | 152 | 18/4.14 | 1/4.14 | 20.68 | 663.3 | 104.6 | 770.9 | 86.4 | 13.6 | 5579 | 0.1189 |
| Flicker | 241.7 | 31.3 | 273 | 152 | 24/3.58 | 7/2.39 | 21.49 | 669.7 | 244.4 | 914.1 | 73.2 | 26.8 | 7802 | 0.1195 |
| Hen | 241.7 | 56.4 | 298.1 | 152 | 30/3.20 | 7/3.20 | 22.40 | 668 | 440 | 1108 | 60.3 | 39.7 | 10590 | 0.1196 |
| Hawk | 241.7 | 39.4 | 281.1 | 152 | 26/3.44 | 7/2.68 | 21.80 | 667.4 | 307.5 | 974.9 | 68.5 | 31.5 | 8820 | 0.1195 |
| Heron | 253.3 | 59.1 | 312.4 | 159.4 | 30/3.28 | 7/3.28 | 22.96 | 701 | 461 | 1162 | 60.3 | 39.7 | 11090 | 0.1141 |
| XX | 282 | 15.7 | 297.7 | 177.4 | 18/4.47 | 1/4.47 | 22.33 | 776.8 | 122 | 898.8 | 86.4 | 13.6 | 6509 | 0.1018 |
| Parakeet | 282 | 36.1 | 318.5 | 177.4 | 24/3.87 | 7/2.58 | 23.22 | 781 | 286 | 1067 | 73.2 | 26.8 | 9004 | 0.1025 |
| Eagle | 282 | 45.9 | 327.9 | 177.4 | 26/3.72 | 7/2.89 | 23.55 | 779 | 358 | 1137 | 68.5 | 31.5 | 10190 | 0.1025 |
| Peacock | 306.6 | 39.8 | 346.8 | 192.8 | 24/4.03 | 7/2.69 | 24.21 | 850 | 309 | 1159 | 73.1 | 26.9 | 9798 | 0.0942 |
| Squab | 306.6 | 49.9 | 356.5 | 192.8 | 26/3.87 | 7/3.01 | 24.54 | 850 | 308 | 1268 | 6.5 | 31.5 | 10954 | 0.0942 |
| Teal | 306.6 | 69.9 | 376.5 | 192.8 | 30/3.61 | 19/2.16 | 25.25 | 851 | 546 | 1397 | 60.8 | 39.2 | 13630 | 0.9439 |
| Duck | 306.6 | 39.8 | 346.4 | 192.8 | 54/2.69 | 7/2.69 | 24.21 | 848 | 310 | 1158 | 73.2 | 26.8 | 10210 | 0.9439 |
| Rook | 322.3 | 41.7 | 364 | 202.7 | 24/4.14 | 7/2.76 | 24.82 | 893 | 326 | 1219 | 73.2 | 26.8 | 10274 | 0.08966 |
| Egrit | 322.3 | 73.3 | 395.6 | 202.7 | 30/3,70 | 19/2.22 | 25.90 | 891 | 575 | 1466 | 60.8 | 39.2 | 14330 | 0.08973 |
| Grosbeak | 322.3 | 52.4 | 374.7 | 202.7 | 26/3.97 | 7/3.09 | 25.15 | 890 | 409 | 1299 | 6.5 | 31.5 | 11340 | 0.08966 |
| Goose | 322.3 | 41.7 | 364 | 202.7 | 54/2.76 | 7/2.76 | 24.84 | 892 | 326 | 1218 | 73.2 | 26.8 | 10730 | 0.08979 |
| Flaningo | 337.8 | 43.8 | 381.6 | 212.3 | 24/4.23 | 7/2.82 | 25.38 | 936 | 347 | 1277 | 73.2 | 26.8 | 10773 | 0.0855 |
| Gull | 337 | 43.7 | 381.5 | 212.3 | 54/2.82 | 7/2.82 | 25.38 | 935 | 341 | 1276 | 73.2 | 26.8 | 11140 | 0.08569 |
| Redwing | 362.5 | 82.6 | 445.1 | 228 | 30/3.92 | 19/2.35 | 27.43 | 1002 | 646 | 1648 | 60.8 | 39.2 | 75690 | 0.07966 |
| Starling | 362.5 | 59.1 | 421.6 | 228 | 26/4.21 | 7/3.28 | 26.68 | 1001 | 461 | 1462 | 68.5 | 31.5 | 12750 | 0.7966 |

## ALUMINIUM CONDUCTOR STEEL REINFORCED-ACSR (FRENCH STANDARD SIZED)

| Area sq. $\mathrm{mm}^{3}$ |  |  | Composition |  |  |  | Ext. diameter of conductor | Nominal Ultimate Strength | Elect, resistance at $20^{\circ} \mathrm{C}$ | conductor Weight | Gross Weight |  | Modu. Of elasticity | Coefficient of expansion |
| :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: |
|  |  |  | Aluminium |  | Steel |  |  |  |  |  | Covered | Uncovered |  |  |
| Total | Alu. | Steel | No. | mm | No. | mm | mm | kg. | $\Omega / \mathrm{km}$. | $\mathrm{kg} / \mathrm{km}$. | $\mathrm{kg} / \mathrm{km}$ | kg/km | hbar | $\times 10^{6}$ |
| 22 | 18.80 | 3.14 | 6 | 2.00 | 1 | 2.00 | 6 | 697 | 1.530 | 76 | 2.5 | 1.5 | 7.500 | 18.7 |
| 34.4 | 29.50 | 4.91 | 6 | 2.50 | 1 | 2.50 | 7.5 | 1055 | 0.977 | 120 | 4 | 2 | 7.500 | 18.7 |
| 37.7 | 28.27 | 9.43 | 9 | 2.00 | 3 | 2.00 | 8.3 | 1540 | 1.020 | 155 | 6 | 3 | 8.650 | 17.1 |
| 54.6 | 46.83 | 7.77 | 6 | 3.15 | 1 | 3.15 | 9.45 | 1620 | 0.616 | 190 | 7 | 2 | 7.500 | 18.7 |
| 59.7 | 37.71 | 21.99 | 12 | 2.00 | 7 | 2.00 | 10 | 3050 | 0.765 | 276 | 7 | 3 | 10.150 | 15.4 |
| 75.5 | 47.71 | 27.99 | 12 | 2.25 | 7 | 2.25 | 11.25 | 3840 | 0.605 | 348 | 8 | 3 | 10.150 | 15.4 |
| 116.2 | 94.24 | 22.00 | 30 | 2.00 | 7 | 2.00 | 14 | 4145 | 0.306 | 432 | 13 | 7 | 7.850 | 18 |
| 147.1 | 119.28 | 27.83 | 30 | 2.25 | 7 | 2.25 | 15.75 | 5200 | 0.243 | 547 | 17 | 8 | 7.850 | 18 |
| 181.6 | 147.26 | 34.34 | 30 | 2.50 | 7 | 2.50 | 17.5 | 6260 | 0.197 | 675 | 21 | 10 | 7.850 | 18 |
| 228 | 184.81 | 43.10 | 30 | 2.80 | 7 | 2.80 | 19.6 | 7710 | 0.157 | 848 | 26 | 13 | 7.850 | 18 |
| 288 | 233.79 | 54.55 | 30 | 3.15 | 7 | 3.15 | 22.05 | 9690 | 0.122 | 1.074 | 33 | 17 | 7.850 | 18 |
| 36.6 | 297.00 | 69.30 | 30 | 3.55 | 7 | 3.55 | 24.85 | 11975 | 0.098 | 1.376 | 43 | 22 | 7.850 | 18 |

The steel strands have an ultimate strength of 117.6hbars.
1 hectobar: $1.02 \mathrm{~kg} . / \mathrm{mm}^{2}$
1 daN : 1.2 kg ./force
These cables are manufactured in accordance with the Standard NF; C 34-120.
CONSTANTS FOR DETERMINING AREA, WEIGHT AND RESISTANCE OF ACSR AND AAC

|  | All Aluminium Conductors |  |  |  |  | ACSR Aluminium conductors surrounding the steel core |  |  |  |  |  | Steel <br> wires in <br> cores |
| :--- | ---: | ---: | ---: | ---: | ---: | ---: | ---: | ---: | ---: | ---: | :---: | :---: |
| Numbers of <br> strands | 3 | 7 | 19 | 37 | 6 | 7 | 26 | 30 | 54 | 7 |  |  |
| Area | 2.961810 | 6.923620 | 18.6988000 | 36.2021000 | 5.923620 | 6.910890 | 25.3692000 | 29.2785000 | 52.6995000 | $\ldots$ |  |  |
| Weight | 3.038680 | 7.077370 | 19.3065000 | 37.8181000 | 6.077370 | 7.090260 | 26.6478000 | 30.7407000 | 55.3343000 | 7.04719 |  |  |
| Resistance | 0.337632 | 0.144433 | 0.0534794 | 0.027623 | 0.168826 | 0.144699 | 0.039418 | 0.034155 | 0.018976 | $\ldots$ |  |  |

LAY RATIOS OF ALUMINIUM CONDUCTORS GALVANIZED STEEL-REINFORCED

| Number of Wires |  | Ratio of Aluminium wire Dia to steel wire diameter layer) | Lay ratios for steel core (6 Wires) |  | Outermost layer |  | Lay ratios for Aluminium Wire |  |  |  |
| :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: |
| Alu. | Steel |  |  |  | Layer benea | iately most | Inter cach Alu | yer or ires 3 wire |
| Min | Max | Min | Max | Min |  |  | Max | Min | Max |  |  |  |
| (1) | (2) | (3) | (4) | (5) | (6) | (7) | (8) | (9) | (10) | (11) |
| 6 | 1 | 1 | - | - | 10 | 14 | - | . | . | . |
| 6 | 7 | 3 | 13 | 28 | 10 | 14 | - | * | - | $\cdot$ |
| 30 | 7 | 1 | 13 | 28 | 10 | 14 | 10 | 16 | $\cdot$ | $\cdot$ |
| 42 | 7 | 1.8 | 13 | 28 | 10 | 14 | 10 | 16 | 10 | 17 |
| 54 | 7 | 1 | 13 | 28 | 10 | 14 | 10 | 16 | 10 | 17 |


| Code Word | Type | $\begin{gathered} \text { Aluminium } \\ \text { Area } \\ \hline \end{gathered}$ |  | Complete of Conductor $\mathrm{mm}^{2}$ | Equiv. in copper $\mathrm{mm}^{2}$ | Diameter in mm |  | Ultimate breaking strength kg | D.C resistance at $20^{\circ} \mathrm{C}$ $\Omega / \mathrm{km}$ | Weight in $\mathrm{kg} / \mathrm{km}$ |  |  | \% of total weight |  | Standard length | Approx. weight of standard length |
| :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: |
|  |  | AWG | $\mathrm{mm}^{2}$ |  |  | Complete Conductor | Steel Core |  |  | Alu. | Steel | Total | Alu. Km | $\begin{aligned} & \text { Steel } \\ & \text { drum } \end{aligned}$ |  |  |
| xx | 100 | 8 | 8.37 | 9.81 | 5.26 | 3.68 | 1.33 | 340 | 3.423 | 33.8 | 22.9 | 10.9 | 67.9 | 32.1 | 8.35 | 280 |
| xx | 100 | 7 | 10.55 | 12.32 | 6.63 | 4.12 | 1.5 | 425 | 2.714 | 42.6 | 28.9 | 13.7 | 67.9 | 32.1 | 6.625 | 280 |
| xx | 100 | 6 | 13.3 | 15.48 | 8.37 | 4.62 | 1.68 | 530 | 2.154 | 53.7 | 36.5 | 17.2 | 67.9 | 32.1 | 5.255 | 280 |
| xx | 100 | 5 | 16.77 | 19.55 | 10.55 | 5.18 | 1.89 | 660 | 1.708 | 67.5 | 45.8 | 21.7 | 67.9 | 32.1 | 4.175 | 280 |
| $x \times$ | 100 | 4 | 21.15 | 24.71 | 13.3 | 5.79 | 2.12 | 630 | 1.354 | 85.3 | 57.9 | 27.4 | 67.9 | 32.1 | 3.31 | 280 |
| xx | 100 | 3 | 26.67 | 31.1 | 16.77 | 6.55 | 2.38 | 1.025 | 1.074 | 107.6 | 72.9 | 34.7 | 67.9 | 32.1 | 2.615 | 280 |
| Xx | 100 | 2 | 33.62 | 39.22 | 21.15 | 7.34 | 2.67 | 1.265 | 0.8507 | 135.9 | 92.2 | 43.7 | 67.9 | 32.1 | 4.16 | 560 |
| xx | 100 | 1 | 42.41 | 49.48 | 26.67 | 8.26 | 3 | 1.585 | 0.6754 | 171.1 | 116.1 | 55 | 57.9 | 32.1 | 3.295 | 560 |
| xx | 100 | 1/0 | 53.49 | 62.39 | 33.62 | 9.25 | 3.37 | 1.94 | 0.5351 | 215.8 | 146.4 | 69.4 | 67.9 | 32.1 | 2.615 | 560 |
| xx | 100 | 2/0 | 67.43 | 78.64 | 42.41 | 10.41 | 3.78 | 2.425 | 0.4245 | 272 | 184.5 | 87.5 | 67.9 | 32.1 | 2.07 | 560 |
| xx | 100 | 3/0 | 85.01 | 99.22 | 53.49 | 11.68 | 4.25 | 3.03 | 0.3387 | 343 | 232.7 | 110.3 | 67.9 | 32.1 | 1.645 | 560 |
| xx | 100 | 4/0 | 107.2 | 125.1 | 67.43 | 13.11 | 4.77 | 3.82 | 0.2671 | 432.5 | 793.5 | 139 | 67.9 | 32.1 | 1.305 | 560 |
| xx | 150 | 8 | 8.37 | 11.16 | 5.26 | 3.91 | 1.89 | 500 | 3.423 | 44.6 | 22.9 | 21.7 | 51.2 | 48.8 | 4.175 | 185 |
| xX | 150 | 7 | 10.55 | 14.13 | 6.63 | 4.37 | 2.12 | 640 | 2.714 | 56.3 | 28.9 | 27.4 | 51.2 | 48.8 | 3.31 | 185 |
| xx | 150 | 6 | 13.3 | 17.74 | 8.37 | 4.9 | 2.38 | 780 | 2.154 | 71.1 | 36.4 | 34.7 | 51.2 | 48.8 | 2.615 | 185 |
| xx | 150 | 5 | 16.77 | 22.39 | 10.55 | 5.49 | 2.67 | 980 | 1.708 | 89.4 | 45.8 | 43.6 | 51.2 | 48.8 | 4.16 | 370 |
| xx | 150 | 4 | 21.15 | 28.26 | 13.3 | 6.17 | 3 | 1.23 | 1.354 | 112.9 | 57.9 | 55 | 51.2 | 48.8 | 3.295 | 370 |
| xx | 150 | 3 | 26.67 | 35.55 | 16.77 | 6.91 | 3.37 | 1.505 | 1.074 | 142.3 | 72.9 | 69.4 | 51.2 | 48.8 | 2.615 | 370 |
| xx | 150 | 2 | 33.62 | 44.84 | 21.15 | 7.82 | 3.78 | 1.88 | 0.8507 | 179.8 | 92.2 | 87.36 | 51.2 | 48.8 | 2.07 | 370 |
| xx | 150 | 1 | 42.41 | 56.58 | 26.67 | 8.79 | 4.25 | 2.355 | 0.6754 | 226.4 | 116.1 | 110.3 | 51.2 | 48.8 | 1.645 | 370 |
| xx | 150 | 1/0 | 53.49 | 71.35 | 33.62 | 9.86 | 4.77 | 2.95 | 0.5351 | 285.4 | 146.4 | 139 | 51.2 | 48.8 | 1.305 | 370 |
| xx | 200 | 8 | 8.37 | 12.84 | 5.26 | 4.19 | 2.38 | 6.85 | 3.423 | 57.6 | 22.9 | 34.7 | 39.8 | 60.2 | 2.615 | 150 |
| Xx | 200 | 7 | 10.55 | 16.19 | 6.63 | 4.67 | 2.67 | 865 | 2.714 | 72.5 | 28.9 | 42.6 | 39.8 | 60.2 | 4.16 | 300 |
| xx | 200 | 6 | 13.30 | 20.39 | 8.37 | 5.28 | 3 | 1.09 | 2.154 | 91.5 | 36.5 | 55 | 39.8 | 60.2 | 3.295 | 300 |
| xx | 200 | 5 | 16.77 | 25.68 | 10.55 | 5.92 | 3.37 | 1.33 | 1.78 | 115.2 | 45.9 | 69.3 | 39.8 | 60.2 | 2.615 | 300 |
| xx | 200 | 4 | 21.15 | 32.39 | 13.3 | 6.71 | 3.78 | 1.67 | 1.354 | 145.4 | 57.9 | 87.5 | 39.8 | 60.2 | 2.07 | 300 |
| xx | 200 | 3 | 26.67 | 40.84 | 16.77 | 7.47 | 4.25 | 2.1 | 1.074 | 183.2 | 72.9 | 110.3 | 39.8 | 60.2 | 1.645 | 300 |
| XX | 200 | 2 | 33.62 | 51.48 | 21.15 | 8.41 | 4.77 | 2.625 | 0.8507 | 231 | 92 | 139 | 39.8 | 60.2 | 1.305 | 300 |

## COMPRESSED ALL ALUMINIUM CONDUCTOR (CANADIAN STANDARD SIZES)

| Toad | 6 | 13.3 | 8.37 | 7 | 4.3 | 265 | 2.149 | 36.3 |
| :--- | ---: | ---: | ---: | ---: | ---: | ---: | ---: | ---: |
| Ozard | 5 | 16.77 | 10.55 | 7 | 4.8 | 335 | 1.704 | 45.8 |
| Dragon | 4 | 21.15 | 13.3 | 7 | 5.4 | 415 | 1.351 | 57.7 |
| Lizard | 3 | 26.67 | 16.77 | 7 | 6.1 | 515 | 1.072 | 72.8 |
| Moloch | 2 | 33.52 | 21.15 | 7 | 6.9 | 635 | 0.85 | 91.8 |
| Monitor | 1 | 42.41 | 26.67 | 7 | 7.6 | 775 | 0.674 | 115.8 |
| Tuatara | $1 / 0$ | 53.49 | 33.62 | 7 | 8.6 | 940 | 0.534 | 146.1 |
| Alligator | $2 / 0$ | 67.43 | 42.41 | 7 | 9.7 | 1.185 | 0.424 | 184.2 |
| Crocodile | $3 / 0$ | 85.01 | 53.49 | 7 | 10.9 | 1.435 | 0.336 | 232.3 |
| Salamander | $4 / 0$ | 107.2 | 67.43 | 7 | 12.2 | 1.81 | 0.267 | 292.9 |
| Komodo | 266.8 | 135.2 | 85.01 | 18 | 13.8 | 2.42 | 0.213 | 370.5 |
| Tadpole | 300 | 152 | 95.6 | 18 | 14.6 | 2.67 | 0.189 | 417.4 |
| Basillisk | 336.4 | 170.5 | 107.2 | 18 | 15.5 | 2.995 | 0.168 | 467.3 |
| Hatteria | 397.5 | 201.4 | 126.7 | 18 | 16.9 | 3.47 | 0.142 | 553 |
| Chuckwalla | 477 | 241.7 | 152 | 18 | 18.5 | 4.08 | 0.119 | 663.5 |

## ALL ALLOY ALUMINIUM CONDUCTOR (FRENCH STANDARD SIZES)

Characteristics

Modulus of elasticity $6120 \mathrm{~kg} / \mathrm{mm}^{2}$
Coefficient of expansion $23 \times 10^{4}$
Coefficient of variation in Electrical Resistance per ${ }^{\circ} \mathrm{C} 0.0036$

| Normal <br> area <br> $\mathrm{mm}^{2}$ | Composition <br> maximum mm | Exterior <br> diameter <br> mm | Approximately <br> weight <br> $\mathrm{kg} / \mathrm{km}$ | Ultimate <br> strength <br> kg | Electrical <br> resistance <br> at $20^{\circ} \mathrm{C}$ <br> $\Omega / \mathrm{km}$ |
| ---: | ---: | ---: | ---: | ---: | ---: |
| 22 | $7 \times 2.00$ | 6 | 60.2 | 725 | 1.5 |
| 34.4 | $7 \times 2.50$ | 7.5 | 94 | 1.125 | 0.958 |
| 43.1 | $7 \times 2.80$ | 8.4 | 118 | 1.415 | 0.769 |
| 54.6 | $7 \times 3.15$ | 9.45 | 149.2 | 1.79 | 0.603 |
| 75.5 | $19 \times 2.25$ | 11.25 | 207.7 | 2.475 | 0.438 |
| 93.3 | $19 \times 2.50$ | 12.5 | 256.3 | 3.06 | 0.357 |
| 117 | $19 \times 2.80$ | 14 | 321.6 | 3.84 | 0.283 |
| 148 | $19 \times 3.15$ | 15.75 | 407 | 4.86 | 0.224 |
| 181 | $37 \times 2.50$ | 17.5 | 500 | 5.96 | 0.183 |
| 228 | $37 \times 2.80$ | 19.6 | 627.5 | 7.485 | 0.146 |
| 288 | $37 \times 3.15$ | 22.05 | 794.1 | 9.465 | 0.115 |
| 366 | $37 \times 3.55$ | 24.85 | 1008.6 | 12.02 | 0.0905 |
| 475 | $61 \times 3.15$ | 28.35 | 1311.9 | 15.605 | 0.0706 |
| 570 | $61 \times 3.45$ | 31.5 | 1.574 | 18.725 | 0.0583 |
| 604 | $61 \times 3.55$ | 31.95 | 1.665 | 19.825 | 0.055 |

## DICABS

## ALUMINIUM ALLOY CONDUCTOR 6201 T. 81 (ASTM STANDARD SIZES)

| Code Word | Section |  | Composition |  | Exterior <br> Cable <br> mm | Cable weight <br> $\mathrm{Kg} / \mathrm{km}$ | Ultimate Strength <br> Kg | Resistance at |  | Intensity <br> Amps | ACSR Cable of equal Diameter |  | Equivalent ACSR Cable Diameter |  |
| :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: |
|  | MCM | mm ${ }^{2}$ | No. | mm |  |  |  | $20^{\circ} \mathrm{C}$ | $50^{\circ} \mathrm{C}$ |  |  | Standing | MCM. | mm |
|  |  |  |  |  |  |  |  |  |  |  | AWG | Standing | AWG | , |
| Akron | 30.58 | 15.49 | 7 | 1.68 | 5.04 | 42 | 477 | 2.161 | 2.385 | 100 | 6 | 6/1 | 25.9 | 13 |
| Alton | 48.69 | 24.67 | 7 | 2.12 | 6.36 | 68 | 760 | 1.357 | 1.498 | 130 | 4 | 6/1 | 41.2 | 20.87 |
| Ames | 77.47 | 39.25 | 7 | 2.57 | 8.01 | 108 | 1.21 | 2.853 | 0.942 | 180 | 2 | 6/1 | 65.6 | 33.24 |
| Azusa | 123.3 | 52.47 | 7 | 3.37 | 10.11 | 172 | 1.925 | 0.536 | 0.592 | 240 | 1/0 | 6/1 | 104.4 | 52.9 |
| Anahim | 155.4 | 78.74 | 7 | 3.78 | 11.34 | 217 | 2.326 | 0.425 | 0.469 | 280 | 2/0 | 6/1 | 131.6 | 66.68 |
| Anherst | 195.7 | 99.16 | 7 | 4.25 | 12.75 | 273 | 2.927 | 0.337 | 0.373 | 325 | 3/0 | 6/1 | 165.7 | 83.96 |
| Alliance | 246.9 | 125.1 | 7 | 4.77 | 14.31 | 345 | 3.695 | 0.267 | 0.296 | 380 | 4/0 | 6/1 | 209.1 | 105.95 |
| Butte | 312.8 | 158.5 | 19 | 3.25 | 16.25 | 436 | 4.626 | 0.211 | 0.233 | 440 | 266.8 | 26/7 | 264.9 | 134,22 |
| Canton | 394.5 | 199 | 19 | 3.66 | 18.13 | 551 | 5.594 | 0.167 | 0.185 | 510 | 336.4 | 26/7 | 334.1 | 169.28 |
| Cario | 465.4 | 235.82 | 19 | 3.97 | 19.85 | 650 | 6.597 | 0.142 | 0.157 | 570 | 397.5 | 26/7 | 394.1 | 199.7 |
| Dairen | 559.5 | 283.5 | 19 | 4.35 | 21.75 | 781 | 7.93 | 0.118 | 0.131 | 630 | 477 | 26/7 | 473.8 | 240.07 |
| Elgin | 652.4 | 330.57 | 19 | 4.7 | 23.15 | 1911 | 9.247 | 0.101 | 0.112 | 710 | 556.5 | 26/7 | 552.4 | 280 |
| Flint | 740.8 | 375.36 | 37 | 3.95 | 25.13 | 1.034 | 10.503 | 0.0891 | 0.0967 | 770 | 636 | 26/7 | 627.3 | 371.8 |
| Greeley | 927.2 | 469.81 | 37 | 4.02 | 28.14 | 1.295 | 13.145 | 0.0712 | 0.0801 | 890 | 795 | 26/7 | 785.1 | 397.8 |

The above cables are manufactured in accordance with ASTM Stand ards B 398.67 and B399-69a.
Resistance value is based on a minimum conductivity of $52.5 \%$ IACS.
Carrying capacity is calculated for an increase of $50^{\circ} \mathrm{C}$ over an ambient temperature of $25^{\circ} \mathrm{C}$ a wind velocity of 0.60 meters / second and a co-efficient of emissivity of 0.5 .

## ALL ALUMINIUM CONDUCTOR -AAC (FRENCH STANDARD SIZES)

| Section <br> Nominal <br> $\mathbf{m m}^{3}$ | Composition <br> $\mathbf{N}^{\circ} \times \mathrm{mm}$ | Exterior <br> diameter <br> $\mathbf{m m}$ | Cable <br> weight <br> $\mathrm{Kg} / \mathrm{Km}$ | Ultimate <br> strength | Electrical <br> resistance <br> at $20^{\circ} \mathrm{C} / \mathrm{Km}$ | Module of <br> elasticity <br> bars | Coefficient <br> of line <br> expansion <br> $\times 10^{\circ}$ |
| :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: |
| 27.8 | $7 \times 2.25$ | 6.75 | 76.2 | 478 | 1.03 | 6 | 23 |
| 34.4 | $7 \times 2.50$ | 7.5 | 94.1 | 576 | 0.833 | 6 | 23 |
| 43.1 | $7 \times 2.80$ | 8.4 | 118 | 706 | 0.664 | 6 | 23 |
| 54.6 | $7 \times 3.15$ | 9.45 | 149.4 | 873 | 0.527 | 6 | 23 |
| 75.5 | $19 \times 2.25$ | 11.25 | 207.9 | 1294 | 0.381 | 5.7 | 23 |
| 93.3 | $19 \times 2.50$ | 12.5 | 256.6 | 1563 | 0.308 | 5.07 | 23 |
| 117 | $19 \times 2.80$ | 14 | 821.9 | 1917 | 0.246 | 5.7 | 23 |
| 148 | $19 \times 3.15$ | 15.75 | 407.4 | 2371 | 0.194 | 5.7 | 23 |
| 188 | $19 \times 3.55$ | 17.75 | 517.4 | 2923 | 0.153 | 5.7 | 23 |
| 228 | $37 \times 2.80$ | 19.6 | 628.2 | 3733 | 0.126 | 5.7 | 23 |
| 288 | $37 \times 3.15$ | 22.05 | 795 | 4617 | 0.1 | 5.7 | 23 |
| 366 | $37 \times 3.55$ | 24.85 | 1009.7 | 5694 | 0.0787 | 5.7 | 23 |
| 475 | $61 \times 3.15$ | 28.35 | 1313.4 | 7206 | 0.0608 | 5.5 | 23 |
| 604 | $61 \times 3.51$ | 31.95 | 1668.1 | 8895 | 0.0479 | 5.5 | 23 |

NOTE: (1) daN $=1.02 \mathrm{~kg}$ of force; (2) 1 hbar $=1.02 \mathrm{~kg} / \mathrm{sp} . \mathrm{mm}$; ; (3) These cables are manufactured according to the Standard C34-120

## ALL ALUMINIUM CONDUCTOR - AAC (DIN STANDARD SIZES)

| Section <br> Nominal | Theoretical <br> area <br> $\mathbf{m m}^{3}$ | Composition <br> $\mathbf{N o}^{\circ} \times \mathbf{m m}$ | Cable <br> diameter <br> $m m$ | Cable <br> weight | Approximately <br> ultimate strength <br> Kgs.f. | Constant <br> load <br> capacity <br> Amp. |
| ---: | ---: | ---: | ---: | ---: | ---: | ---: |
| 25 | 24.25 | $7 \times 2.1$ | 6.3 | 67 | 425 | 145 |
| 35 | 34.36 | $7 \times 2.5$ | 7.5 | 94 | 585 | 180 |
| 50 | 49.48 | $7 \times 3.0$ | 9 | 135 | 810 | 225 |
| 50 | 48.36 | $19 \times 1.8$ | 9 | 133 | 860 | 225 |
| 70 | 65.82 | $19 \times 2.1$ | 10.5 | 181 | 1150 | 270 |
| 95 | 93.27 | $19 \times 2.5$ | 12.5 | 256 | 1595 | 340 |
| 120 | 1117 | $19 \times 2.8$ | 14 | 322 | 1910 | 390 |
| 150 | 147.1 | $37 \times 2.25$ | 15.7 | 406 | 2570 | 455 |
| 185 | 181.6 | $37 \times 2.5$ | 17.5 | 501 | 3105 | 520 |
| 240 | 242.5 | $61 \times 2.25$ | 20.2 | 670 | 4015 | 625 |
| 300 | 299.4 | $61 \times 2.5$ | 222.5 | 827 | 4850 | 710 |
| 400 | 400.1 | $61 \times 2.89$ | 28 | 1105 | 6190 | 855 |
| 500 | 499.8 | $61 \times 3.23$ | 29.1 | 1381 | 7670 | 990 |
| 625 | 626.2 | $91 \times 2.96$ | 32.6 | 1733 | 9610 | 1140 |
| 800 | 802.1 | $91 \times 3.35$ | 36.8 | 2219 | 12055 | 1340 |
| 1000 | 999.7 | $91 \times 3.74$ | 41.1 | 2766 | 14845 | 1540 |

Theoretical values valid up to 60 Hz for a wind velocity of $0.6 \mathrm{~m} / \mathrm{sec}$. and solar action for an initial temperature of $35^{\circ} \mathrm{C}$ and an ultimate cable temperature of $80^{\circ} \mathrm{C}$. In the case of unusual placement without air movement, these values will be reduced on an average of $30 \%$ approximately.

## ALL ALUMINIUM ALLOY CONDUCTOR (AAAC)

DIN 48201/6

| Cross Section |  | Construction |  |  |  |  |  |  |  |
| :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: |
| Nominal | Actual | No. of <br> wires | Wire <br> diameter | Complete <br> Conductor <br> diameter | Cond. <br> Weight <br> approx. | Calculated <br> breaking load | Resistance <br> at $20^{\circ} \mathrm{C}$ | Current <br> carrying <br> Capacity |  |
| $\mathrm{mm}^{2}$ | $\mathrm{~mm}^{2}$ |  | mm | mm | $\mathrm{~kg} / \mathrm{km}$ | kN | $\Omega / \mathrm{km}$ | A |  |
| 16 | 15.89 | 7 | 1.70 | 5.1 | 43 | 4.44 | 2.090 | 105 |  |
| 25 | 24.25 | 7 | 2.10 | 6.3 | 66 | 6.77 | 1.370 | 135 |  |
| 35 | 34.36 | 7 | 2.50 | 7.5 | 94 | 9.6 | 0.967 | 170 |  |
| 50 | 49.48 | 7 | 3.00 | 9.0 | 135 | 13.82 | 0.671 | 210 |  |
| 50 | 48.35 | 19 | 1.80 | 9.0 | 133 | 13.5 | 0.690 | 210 |  |
| 70 | 65.81 | 19 | 2.10 | 10.5 | 181 | 18.38 | 0.507 | 255 |  |
| 95 | 93.27 | 19 | 2.50 | 12.5 | 256 | 26.05 | 0.358 | 320 |  |
| 120 | 116.99 | 19 | 2.80 | 14.0 | 322 | 32.68 | 0.285 | 365 |  |
| 150 | 147.11 | 37 | 2.25 | 15.8 | 406 | 41.09 | 0.227 | 425 |  |
| 185 | 181.62 | 37 | 2.50 | 17.5 | 500 | 50.73 | 0.184 | 490 |  |
| 240 | 242.54 | 61 | 2.25 | 20.3 | 670 | 67.47 | 0.138 | 585 |  |
| 300 | 299.43 | 61 | 2.50 | 22.5 | 827 | 83.63 | 0.112 | 670 |  |
| 400 | 400.14 | 61 | 2.89 | 26.0 | 1.104 | 111.76 | 0.084 | 810 |  |
| 500 | 499.83 | 61 | 3.23 | 29.1 | 1.379 | 139.6 | 0.067 | 930 |  |
| 625 | 626.20 | 91 | 2.96 | 32.6 | 1.732 | 174.9 | 0.054 | 1075 |  |
| 800 | 802.09 | 91 | 3.35 | 36.9 | 2.218 | 224.02 | 0.042 | 1255 |  |

## DICABS

## ALUMINIUM CONDUCTORS (AAC)

ASTM B 231 CSA-Standard C 49.3-1977

| Code Word | Cross section (Actual) | No. of wires | Wire diameter | Complete Conductor diameter | Conductor weight approx. | Calculated breaking load | Resistance at $20^{\circ} \mathrm{C}$ |
| :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: |
|  | $\mathrm{mm}^{2}$ |  | mm | mm | kg/km | KN | $\Omega / \mathrm{Km}$ |
| PEACHBELL | 13.21 | 7 | 1.55 | 4.65 | 36.5 | 2.47 | 95 |
| ROSE | 21.12 | 7 | 1.96 | 5.88 | 58.2 | 3.94 | 130 |
| IRIS | 33.54 | 7 | 2.47 | 7.41 | 92.5 | 5.95 | 175 |
| ANSY | 42.49 | 7 | 2.78 | 8.34 | 117.1 | 7.01 | 200 |
| POPPY | 53.52 | 7 | 3.12 | 9.36 | 147.6 | 8.73 | 235 |
| ASTER | 67.35 | 7 | 3.50 | 10.50 | 185.7 | 10.99 | 270 |
| PHLOX | 84.91 | 7 | 3.93 | 11.79 | 234.1 | 13.45 | 315 |
| OXLIP | 106.9 | 7 | 4.41 | 13.23 | 294.7 | 16.92 | 365 |
| SNEEZEWORT | 126.7 | 7 | 4.80 | 14.40 | 348.5 | 20.06 | 405 |
| VALERIAN | 126.4 | 19 | 2.91 | 14.55 | 349.3 | 20.57 | 405 |
| DAISY | 135.3 | 7 | 4.96 | 14.80 | 372.8 | 21.43 | 420 |
| LAUREL | 135.2 | 19 | 3.01 | 15.05 | 373.0 | 22.00 | 425 |
| PEONY | 151.9 | 19 | 3.19 | 15.95 | 418.8 | 24.02 | 455 |
| TULIP | 170.5 | 19 | 3.38 | 16.90 | 470.1 | 26.97 | 495 |
| DAFFODIL | 177.6 | 19 | 3.45 | 17.25 | 489.7 | 28.08 | 506 |
| CANNA | 202.1 | 19 | 3.68 | 18.40 | 557.2 | 31.95 | 550 |
| GOLDENTFT | 228.1 | 19 | 3.91 | 19.55 | 628.9 | 35.00 | 545 |
| COSMOS | 241.2 | 19 | 4.02 | 20.10 | 665.0 | 37.01 | 615 |
| SYRINGA | 241.0 | 37 | 2.88 | 20.16 | 664.5 | 38.38 | 615 |
| ZINNIA | 253.3 | 19 | 4.12 | 20.60 | 698.4 | 38.87 | 635 |
| HYACINTH | 252.9 | 37 | 2.95 | 20.65 | 697.3 | 40.27 | 635 |
| DAHLIA | 282.4 | 19 | 4.35 | 21.75 | 778.6 | 43.33 | 680 |
| MISTLETOE | 281.1 | 37 | 3.11 | 21.77 | 775.0 | 43.99 | 680 |
| MEADOWSWEET | 303.2 | 37 | 3.23 | 22.61 | 835.9 | 46.91 | 715 |
| ORCHID | 322.2 | 37 | 3.33 | 23.31 | 888.3 | 49.84 | 745 |
| HEUCHERA | 330.0 | 37 | 3.37 | 23.59 | 909.8 | 51.05 | 755 |
| VERBENA | 354.0 | 37 | 3.49 | 24.43 | 976.0 | 54.76 | 790 |
| FLAG | 354.5 | 61 | 2.72 | 24.48 | 977.4 | 57.43 | 790 |
| VIOLET | 362.1 | 37 | 3.53 | 24.71 | 998.3 | 56.02 | 800 |
| NSTURTIUM | 362.3 | 61 | 2.75 | 24.75 | 998.9 | 58.69 | 800 |
| PETUNIA | 330.8 | 37 | 3.62 | 25.34 | 1050 | 58.91 | 825 |
| CATTAIL | 381.0 | 61 | 2.82 | 25.38 | 1050 | 60.01 | 825 |
| ARBUTUS | 402.1 | 37 | 3.72 | 26.04 | 1109 | 62.20 | 855 |
| LILAC | 402.9 | 61 | 2.90 | 26.10 | 1111 | 63.46 | 855 |
| COCKSCOMB | 455.7 | 37 | 3.96 | 27.72 | 1256 | 67.67 | 925 |
| SNAODRAGON | 457.4 | 61 | 3.09 | 27.81 | 1261 | 69.98 | 925 |
| MAGNOLIA | 483.4 | 37 | 4.08 | 28.56 | 1333 | 72.58 | 960 |
| GOLDENROD | 484.5 | 61 | 3.18 | 28.62 | 1336 | 74.13 | 960 |
| HAWKWEED | 507.7 | 37 | 4.18 | 29.26 | 1400 | 76.23 | 990 |
| CAMELLIA | 506.0 | 61 | 3.25 | 29.25 | 1395 | 77.42 | 990 |
| BLUEBELL | 524.9 | 37 | 4.25 | 29.75 | 1447 | 78.81 | 1015 |
| LARKSKPUR | 524.9 | 61 | 3.31 | 29.79 | 1447 | 80.31 | 1015 |
| MARIGOLD | 563.6 | 61 | 3.43 | 30.87 | 1554 | 86.23 | 1040 |
| HAWTHORN | 603.8 | 61 | 3.55 | 31.95 | 1665 | 92.38 | 1085 |
| NARCISSUS | 645.3 | 61 | 3.67 | 33.03 | 1779 | 98.73 | 1130 |
| COLUMBINE | 684.5 | 61 | 3.78 | 34.02 | 1887 | 104.7 | 1175 |
| CARNATION | 766.6 | 61 | 3.89 | 35.01 | 1999 | 107.7 | 1220 |
| GLADIOLUS | 725.0 | 61 | 4.00 | 36.00 | 2114 | 113.8 | 1265 |
| COREOPSIS | 805.4 | 61 | 4.10 | 36.90 | 2221 | 119.6 | 1305 |
| JESSAMINE | 885.8 | 61 | 4.30 | 38.70 | 2442 | 131.5 | 1385 |
| COWSLIP | 1010 | 91 | 3.76 | 41.36 | 2785 | 152.8 | 1500 |
| AGEBRUSH | 1138 | 91 | 3.99 | 43.89 | 3168 | 167.1 | 1600 |
| LUPINE | 1267 | 91 | 4.21 | 46.31 | 3527 | 186.1 | 1700 |
| BITTERROT | 1396 | 91 | 4.42 | 48.62 | 3887 | 205.0 | 1795 |
| TRILLIUM | 1517 | 127 | 3.90 | 50.70 | 4223 | 222.8 | 1885 |
| BLUEBONNET | 1776 | 127 | 4.22 | 54.86 | 4993 | 260.8 | 2035 |

DICABS

## ALUMINIUM CONDUCTORS STEEL REINFORCED (ACSR)

## BS 215 Part 2

$\left.\begin{array}{|l|r|r|r|r|r|r|r|r|r|r|r|r|}\hline \text { Cord word } & \begin{array}{c}\text { Total } \\ \text { Cross } \\ \text { section }\end{array} & \begin{array}{c}\text { Complete } \\ \text { conductor } \\ \text { diameter }\end{array} & \begin{array}{c}\text { conductor } \\ \text { weight } \\ \text { approx. }\end{array} & \begin{array}{c}\text { Calculated } \\ \text { breaking } \\ \text { load. }\end{array} & \begin{array}{c}\text { current } \\ \text { carrying } \\ \text { capacity }\end{array} & \begin{array}{c}\text { Alu. }\end{array} & \begin{array}{c}\text { Steel }\end{array} & \begin{array}{c}\text { Construcion } \\ \text { steel }\end{array} & \begin{array}{c}\text { Section } \\ \text { Steel }\end{array} & \begin{array}{c}\text { Construction } \\ \text { Aluminium }\end{array} \\ \text { Section } \\ \text { Aluminium }\end{array}\right]$

## ALL ALUMINIUM ALLOY CONDUCTORS (AAAC)

ASTM B 399
BS 3242: 1970

| CODE WORD | CROSS <br> SECTION <br> (Nominal) | Actual | No. of wires | Wire diameter | Complete conductor diameter | Conductor weight approx. | Calculated breaking load |
| :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: |
|  | $\mathrm{mm}^{2}$ | $\mathrm{mm}^{2}$ |  | mm | mm | kg/km | kN |
| - | 10 | 11.88 | 7 | 1.47 | 4.41 | 32.8 | 3.76 |
| AKRON |  | 15.52 | 7 | 1.68 | 5.04 | 42.8 | 4.92 |
| BOX | 15 | 18.82 | 7 | 1.85 | 5.55 | 51.9 | 5.96 |
| ACACIA | 20 | 23.79 | 7 | 2.08 | 6.24 | 65.6 | 7.54 |
| ALTON |  | 24.71 | 7 | 2.12 | 6.36 | 68.1 | 7.83 |
| ALMOND | 25 | 30.10 | 7 | 2.34 | 7.02 | 83.0 | 9.53 |
| CEDAR | 30 | 35.47 | 7 | 2.54 | 7.62 | 97.8 | 11.20 |
| MES |  | 39.19 | 7 | 2.67 | 8.01 | 108.0 | 12.42 |
| - | 35 | 42.18 | 7 | 2.77 | 8.31 | 116.3 | 13.40 |
| FIR | 40 | 47.84 | 7 | 2.95 | 8.85 | 131.9 | 15.10 |
| HAZEL | 50 | 59.87 | 7 | 3.30 | 9.90 | 165.1 | 20.00 |
| AZUZA |  | 62.44 | 7 | 3.37 | 10.11 | 172.2 | 19.78 |
| PINE | 60 | 71.65 | 7 | 3.61 | 10.83 | 197.5 | 22.70 |
| ANAHEIM |  | 78.55 | 7 | 3.78 | 11.34 | 216.6 | 23.75 |
| - | 79 | 84.05 | 7 | 3.91 | 11.73 | 231.7 | 25.40 |
| WILLOW | 75 | 89.73 | 7 | 4.04 | 12.12 | 247.4 | 27.10 |
| $-$ | 80 | 96.52 | 7 | 4.19 | 12.57 | 266.1 | 29.20 |
| AMHERST |  | 99.30 | 7 | 4.25 | 12.75 | 273.8 | 30.03 |
| - | 90 | 108.40 | 7 | 4.44 | 13.32 | 298.9 | 32.80 |
| OAK | 100 | 118.90 | 7 | 4.65 | 13.95 | 327.8 | 36.00 |
| ALLIANCE | 100 | 125.10 | 7 | 4.7 | 14.31 | 344.9 | 37.83 |
| MULBERRY |  | 150.90 | 19 | 3.18 | 15.90 | 416.0 | 46.3 |
| BUTTE | 125 | 158.60 | 19 | 3.26 | 16.30 | 437.3 | 48.67 |
| ASH | 150 | 180.70 | 19 | 3.48 | 17.40 | 498.2 | 52.90 |
| CANTON | 150 | 199.90 | 19 | 3.66 | 18.30 | 551.1 | 58.56 |
| ELM |  | 211.00 | 19 | 3.76 | 18.80 | 581.7 | 61.8 |
| CAIRO | 175 | 236.40 | 19 | 3.98 | 19.90 | 651.8 | 69.25 |
| POPLAR |  | 239.40 | 37 | 2.87 | 20.09 | 660.0 | 71.90 |
| - | 200 | 270.30 | 37 | 3.05 | 21.35 | 745.2 | 81.20 |
| DARIEN | 225 | 283.70 | 19 | 4.36 | 21.80 | 782.2 | 83.11 |
| SYCAMORE |  | 2301.30 | 37 | 3.22 | 22.54 | 830.7 | 90.50 |
| ELGIN | 250 | 331.00 | 19 | 4.71 | 23.55 | 912.6 | 96.97 |
| UPAS | 300 | 362.10 | 37 | 3.53 | 24.71 | 998.3 | 103.80 |
| FLINT |  | 374.50 | 37 | 3.59 | 25.13 | 1033.0 | 107.40 |
| - | 350 | 421.80 | 37 | 3.81 | 26.67 | 1163.0 | 120.90 |
| GREELEY |  | 469.60 | 37 | 4.02 | 28.14 | 1295.0 | 134.6 |
| YEW | 400 | 479.00 | 37 | 4.06 | 28.42 | 1321.0 | 137.3 |

AWG/MCM versus metric conductor sizes

| AWG | $\mathrm{mm}^{2}$ | AWG | $\mathrm{mm}^{2}$ | AWG | $\mathrm{mm}^{2}$ |
| :---: | :---: | :---: | :---: | :---: | :---: |
| 2000 MCM | 994.0 | $4 / 0$ | 107.2 | 15 | 1.65 |
| 1750 MCM | 870.0 | $3 / 0$ | 85.0 | 16 | 1.30 |
| 1500 MCM | 745.0 | $2 / 0$ | 67.4 | 17 | 1.039 |
| 1250 MCM | 621.0 | $1 / 0$ | 53.5 | 18 | 0.821 |
| 1000 MCM | 506.0 | 1 | 42.4 | 19 | 0.654 |
| 900 MCM | 457.4 | 2 | 33.7 | 20 | 0.517 |
| 800 MCM | 405.7 | 3 | 26.7 | 21 | 0.411 |
| 750 MCM | 381.0 | 4 | 21.2 | 22 | 0.324 |
| 700 MCM | 354.5 | 5 | 16.7 | 23 | 0.259 |
| 650 MCM | 328.9 | 6 | 13.3 | 24 | 0.205 |
| 600 MCM | 303.2 | 7 | 10.5 | 25 | 0.162 |
| 550 MCM | 279.3 | 8 | 8.36 | 26 | 0.128 |
| 500 MCM | 252.9 | 9 | 6.63 | 27 | 0.107 |
| 450 MCM | 227.8 | 10 | 5.26 | 28 | 0.080 |
| 400 MCM | 203.2 | 11 | 4.17 | 29 | 0.065 |
| 350 MCM | 177.6 | 12 | 3.30 | 30 | 0.05 |
| 300 MCM | 151.8 | 13 | 2.62 |  |  |
| 250 MCM | 126.4 | 14 | 2.08 |  |  |

## DICABS

## ALUMINIUM CONDUCTORS STEEL REINFORCED (ACSR) -DIN 48204

| Nominal cross Section Al./St. | Total <br> Cross <br> Section | Conductor Diameter | Conductor weight approx. | Calc. Breaking Load | Elec <br> Resistance at $20^{\circ} \mathrm{C}$ | Steel Construction | Steel <br> Cross <br> Section | Alu. Construction | Alu. <br> Cross <br> Section | Alu. Portion | Steel Portion |
| :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: |
| mm ${ }^{2}$ | $\mathrm{mm}^{2}$ | mm | $\mathrm{Kg} / \mathrm{km}$ | kN | $\Omega / \mathrm{km}$ | mm | $\mathrm{mm}^{2}$ | mm | $\mathrm{mm}^{2}$ | \% | \% |
| 16/2.5 | 17.8 | 5.4 | 62 | 5.81 | 1.871 | $1 \times 1.80$ | 2.54 | $6 \times 1.80$ | 15.27 | 67.6 | 32.4 |
| 25/4 | 27.8 | 6.8 | 97 | 9.02 | 1.198 | $1 \times 2.25$ | 3.98 | $6 \times 2.25$ | 23.86 | 67.6 | 32.4 |
| 35/6 | 40.1 | 8.1 | 140 | 12.70 | 0.835 | $1 \times 2.70$ | 5.73 | $6 \times 2.70$ | 34.35 | 67.4 | 32.6 |
| 44/32 | 75.7 | 11.2 | 373 | 45.46 | 0.694 | $7 \times 2.40$ | 31.67 | $14 \times 2.00$ | 43.98 | 32.4 | 67.6 |
| 50/8 | 56.3 | 9.6 | 196 | 17.18 | 0.595 | $1 \times 3.20$ | 8.04 | $6 \times 3.20$ | 48.25 | 67.6 | 32.4 |
| 50/30 | 81 | 11.7 | 378 | 44.28 | 0.558 | $7 \times 2.33$ | 29.85 | $12 \times 2.33$ | 51.17 | 37.2 | 62.8 |
| 70/12 | 81.3 | 11.7 | 284 | 26.31 | 0.413 | 7×1.44 | 11.4 | $26 \times 1.85$ | 69.89 | 67.6 | 32.4 |
| 94/22 | 116.2 | 14.0 | 432 | 44.10 | 0.307 | $7 \times 2.00$ | 22.00 | $30 \times 2.00$ | 94.20 | 59.9 | 40.1 |
| 95/15 | 109.7 | 13.6 | 383 | 35.17 | 0.306 | 7×1.67 | 15.33 | $26 \times 2.15$ | 94.35 | 67.8 | 32.2 |
| 95/34 | 131.1 | 14.9 | 537 | 58.10 | 0.299 | $7 \times 2.50$ | 34.36 | $36 \times 1.85$ | 96.77 | 49.5 | 50.5 |
| 95/55 | 152.8 | 16.0 | 714 | 80.20 | 0.297 | $7 \times 3.20$ | 56.30 | $12 \times 3.20$ | 96.51 | 37.1 | 62.9 |
| 105/75 | 181.2 | 17.5 | 899 | 106.69 | 0.271 | $19 \times 2.25$ | 75.55 | $14 \times 3.10$ | 105.67 | 32.3 | 67.6 |
| 120/20 | 141.4 | 15.5 | 494 | 44.94 | 0.243 | $7 \times 1.90$ | 19.85 | $26 \times 2.44$ | 121.57 | 67.6 | 32.4 |
| 120/42 | 160.4 | 16.5 | 654 | 70.10 | 0.245 | $7 \times 2.75$ | 41.58 | $36 \times 2.05$ | 118.82 | 49.9 | 50.1 |
| 120/70 | 193.4 | 18.0 | 904 | 98.16 | 0.241 | $7 \times 3.60$ | 71.25 | $12 \times 3.60$ | 122.15 | 37.1 | 62.9 |
| 125/30 | 157.8 | 16.3 | 590 | 57.86 | 0.226 | $7 \times 2.33$ | 29.85 | $30 \times 2.33$ | 127.92 | 59.5 | 40.5 |
| 150/25 | 173.1 | 17.1 | 604 | 54.37 | 0.194 | $7 \times 2.10$ | 24.25 | $26 \times 2.70$ | 148.86 | 67.7 | 32.3 |
| 150/53 | 202.4 | 18.5 | 827 | 86.05 | 0.193 | $7 \times 3.10$ | 52.83 | $36 \times 2.30$ | 149.57 | 49.9 | 50.1 |
| 170/40 | 211.9 | 18.9 | 794 | 77.01 | 0.167 | $7 \times 2.70$ | 40.08 | $30 \times 2.70$ | 171.77 | 59.4 | 40.6 |
| 185/30 | 213.6 | 19.0 | 744 | 66.28 | 0.156 | $7 \times 2.33$ | 29.85 | $26 \times 3.00$ | 183.78 | 67.8 | 32.2 |
| 210/35 | 243.2 | 20.3 | 850 | 74.90 | 0.138 | $7 \times 2.49$ | 34.09 | $26 \times 3.20$ | 209.10 | 67.6 | 32.4 |
| 210/50 | 261.5 | 21.0 | 981 | 93.90 | 1.136 | $7 \times 3.00$ | 49.48 | $30 \times 3.00$ | 212.06 | 59.4 | 40.6 |
| 230/30 | 260.8 | 21.0 | 877 | 73.10 | 0.124 | $7 \times 2.33$ | 29.85 | $24 \times 3.50$ | 230.91 | 72.3 | 27.7 |
| 240/40 | 282.5 | 21.9 | 987 | 86.40 | 0.119 | $7 \times 2.68$ | 39.49 | $26 \times 3.45$ | 243.05 | 76.6 | 32.4 |
| 257/60 | 316.5 | 23.1 | 1177 | 109.95 | 0.113 | $7 \times 3.30$ | 59.87 | $30 \times 3.30$ | 256.59 | 59.9 | 40.1 |
| 265/35 | 297.8 | 22.4 | 1002 | 83.05 | 0.109 | $7 \times 2.49$ | 34.09 | $24 \times 3.74$ | 263.56 | 72.3 | 27.7 |
| 300/50 | 353.7 | 24.5 | 1236 | 107.00 | 0.095 | $7 \times 3.00$ | 49.48 | $26 \times 3.86$ | 304.26 | 67.6 | 32.4 |
| 305/40 | 344.1 | 24.1 | 1155 | 99.30 | 0.094 | $7 \times 2.68$ | 39.49 | $54 \times 2.68$ | 304.62 | 72.4 | 27.6 |
| 340/30 | 369.1 | 25.0 | 1174 | 92.56 | 0.086 | $7 \times 2.33$ | 29.85 | $48 \times 3.00$ | 339.29 | 79.4 | 20.6 |
| 340/110 | 450 | 27.7 | 1799 | 187.60 | 0.085 | $19 \times 2.70$ | 108.79 | $78 \times 2.36$ | 341.20 | 52.1 | 47.9 |
| 380/50 | 431.2 | 27.0 | 1448 | 120.91 | 0.075 | 7 $\times 3.00$ | 49.48 | $54 \times 3.00$ | 381.70 | 72.4 | 27.6 |
| 385/35 | 420.1 | 26.7 | 1336 | 104.31 | 0.074 | $7 \times 2.49$ | 34.09 | $48 \times 3.20$ | 386.04 | 79.4 | 20.6 |
| 435/55 | 490.6 | 28.8 | 1647 | 136.27 | 0.066 | $7 \times 3.20$ | 56.30 | $54 \times 3.20$ | 434.29 | 72.4 | 27.6 |
| 450/40 | 488.2 | 28.7 | 1553 | 120.19 | 0.064 | $7 \times 2.68$ | 39.49 | $48 \times 3.45$ | 448.71 | 79.4 | 20.8 |
| 490/56 | 553.8 | 30.6 | 1860 | 152.85 | 0.059 | $7 \times 3.40$ | 63.55 | $54 \times 3.40$ | 490.28 | 72.4 | 27.6 |
| 495/35 | 528.4 | 29.9 | 1636 | 120.31 | 0.058 | $7 \times 2.49$ | 34.09 | $45 \times 3.74$ | 494.36 | 83.0 | 17.0 |
| 510/45 | 555.8 | 30.7 | 1770 | 134.33 | 0.056 | $7 \times 2.87$ | 45.28 | $48 \times 3.68$ | 510.54 | 79.2 | 20.8 |
| $550 / 70$ | 620.9 | 32.4 | 2085 | 167.42 | 0.052 | $7 \times 3.60$ | 71.25 | $54 \times 3.60$ | 549.65 | 72.4 | 27.6 |
| 560/50 | 611.2 | 32.2 | 1943 | 146.28 | 0.051 | $7 \times 3.00$ | 49.48 | $48 \times 3.86$ | 561.7 | 79.4 | 20.6 |
| 570/40 | 610.7 | 32.2 | 1889 | 137.98 | 0.050 | $7 \times 2.68$ | 39.49 | $45 \times 4.02$ | 571.61 | 83.0 | 17.0 |
| 650/45 | 698.8 | 34.4 | 2163 | 155.52 | 0.044 | $7 \times 2.87$ | 45.28 | $45 \times 4.30$ | 653.49 | 83.0 | 17.0 |
| 680/85 | 764.5 | 36.0 | 2564 | 209.99 | 0.042 | $19 \times 2.40$ | 85.95 | $54 \times 4.00$ | 678.58 | 72.7 | 27.3 |
| 1045/45 | 1090.9 | 43.0 | 3249 | 217.87 | 0.027 | $7 \times 2.87$ | 45.28 | $72 \times 4.30$ | 1045.58 | 88.4 | 11.6 |

ALUMINIUM CONDUCTORS STEEL REINFORCED (ACSR) CSA-C49,1

| Code word | Total cross section | complete conductor diameter | Conductor weight approx. | Calculated breaking load | Current <br> carrying capacity | Construction Steel | Section Steel | Construction on Aluminium | section Alu. | Alu. | Steel |
| :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: |
|  | $\mathrm{mm}^{2}$ | mm | kg/km | kN | A | mm | $\mathrm{mm}^{2}$ | mm | $\mathrm{mm}^{2}$ | \% | \% |
| TURKEY | 15.52 | 5.04 | 53.7 | 5.28 | 95 | $1 \times 1.68$ | 2.22 | 6x1.68 | 13.30 | 68.0 | 32.0 |
| TRUSH | 19.55 | 5.67 | 67.6 | 6.47 |  | $1 \times 1.89$ | 2.80 | 6×1.89 | 16.77 | 68.1 | 31.9 |
| SWAN | 24.71 | 6.36 | 85.6 | 8.39 | 130 | 1 $\times 2.12$ | 3.61 | $6 \times 2.12$ | 21.1 | 67.7 | 32.3 |
| SWANATE | 26.47 | 6.53 | 99.6 | 10.52 | 130 | $1 \times 2.61$ | 5.35 | 7×1.96 | 21.12 | 58.2 | 41.8 |
| SWALLOW | 31.1 | 7.14 | 107.6 | 10.05 |  | $1 \times 2.38$ | 4.44 | $6 \times 2.38$ | 26.67 | 68.1 | 31.9 |
| SPARROW | 39.19 | 8.01 | 135.8 | 12.68 | 175 | $1 \times 2.67$ | 5.60 | $6 \times 2.67$ | 33.59 | 67.9 | 32.1 |
| SPARATE | 42.09 | 8.24 | 158.5 | 16.13 | 175 | $7 \times 3.30$ | 8.55 | $7 \times 2.47$ | 33.54 | 58.1 | 41.9 |
| ROBIN | 49.48 | 9 | 171.4 | 15.81 | 200 | $7 \times 3.00$ | 7.07 | $6 \times 3.00$ | 42,41 | 68 | 32 |
| RAVEN | 62.44 | 10.11 | 216.2 | 19.35 | 230 | $7 \times 3.37$ | 8.92 | $6 \times 3.37$ | 53.52 | 68 | 32 |
| QUAIL | 78.55 | 11.34 | 271.8 | 23.59 | 265 | $7 \times 3.78$ | 11.22 | $6 \times 3.78$ | 67.33 | 68 | 32 |
| PIGEON | 99.30 | 12.75 | 343.8 | 29.41 | 310 | $1 \times 4.25$ | 14.18 | $6 \times 4.25$ | 85.12 | 68 | 32 |
| PENGUIN | 125.10 | 14.31 | 433.4 | 37.09 | 350 | $7 \times 4.77$ | 17.90 | $6 \times 4.77$ | 107.20 | 67.9 | 32.1 |
| WAXWING | 142.50 | 15.45 | 430.6 | 30.27 | 430 | $1 \times 3.09$ | 7.50 | $18 \times 3.09$ | 135.00 | 86.1 | 13.9 |
| OWL | 153.00 | 16.09 | 510.6 | 42.93 | 410 | $7 \times 1.79$ | 17.60 | $6 \times 5.36$ | 135.40 | 72.8 | 27.2 |
| PARTRIDGE | 156.90 | 16.28 | 545.6 | 50.25 | 440 | $7 \times 2.00$ | 22.00 | $26 \times 2.57$ | 134.90 | 67.9 | 32.1 |
| OSTRICH | 176.70 | 17.28 | , 12.7 | 56.15 |  | $7 \times 2.12$ | 24.70 | $26 \times 2.73$ | 152.00 | 68.1 | 31.9 |
| MERLIN | 179.70 | 17.35 | /543.2 | 38.22 | 500 | $1 \times 3.47$ | 9.50 | $18 \times 3.47$ | 170.20 | 86.0 | 14.0 |
| LINNET | 198.40 | 81.31 | 698.8 | 62.73 | 510 | $7 \times 2.25$ | 27.80 | $26 \times 2.89$ | 170.60 | 67.9 | 32.1 |
| ORIOLE | 210.30 | 18.83 | 784.7 | 77.45 | 515 | $7 \times 2.69$ | 39.80 | $30 \times 2.69$ | 170.50 | 59.7 | 40.3 |
| CHICKADEE | 212.10 | 18.85 | 640.5 | 44.34 | 555 | $1 \times 3.77$ | 11.20 | $18 \times 3.77$ | 200.90 | 86.1 | 13.9 |
| BRANT | 227.70 | 19.62 | 762.4 | 64.70 | 565 | $7 \times 2.18$ | 26.10 | $24 \times 3.27$ | 201.60 | 72.6 | 27.4 |
| IBIS | 234.10 | 19.88 | 813.9 | 72.13 | 570 | $7 \times 2.44$ | 32.80 | $26 \times 3.14$ | 201.30 | 67.9 | 32.1 |
| LARK | 247.80 | 20.44 | 924.7 | 90.33 | 575 | $7 \times 2.92$ | 46.90 | $30 \times 2.92$ | 200.90 | 59.7 | 40.3 |
| PELICAN | 255.80 | P0.7 | 773.0 | 52.34 | 625 | $1 \times 4.14$ | 13.15 | $18 \times 4.14$ | 242.30 | 86.1 | 13.9 |
| FLICKER | 273.00 | 21.49 | 914.7 | 76.78 | 635 | $7 \times 2.39$ | 31.40 | $24 \times 3.58$ | 241.60 | 72.5 | 27.5 |
| HAWK | 281.10 | 21.8 | 977.9 | 86.73 | 640 | $7 \times 2.68$ | 39.50 | $26 \times 3.44$ | 241.60 | 67.8 | 32.2 |
| HEN | 297.60 | / 22.4 | 1110.4 | 105.20 | 645 | $7 \times 3.20$ | 56.30 | $30 \times 3.20$ | 241.30 | 59.8 | 40.2 |
| OSPREY | 298.20 | 22.35 | 901.0 | 60.98 | 690 | $1 \times 4.47$ | 15.70 | $18 \times 4.47$ | 282.50 | 86.1 | 13.9 |
| HERON | 312.40 | 22.96 | 1162.0 | 108.68 |  | $7 \times 3.28$ | 59.14 | $30 \times 3.28$ | 253.30 | 59.9 | 40.1 |
| PARAKEET | 318.90 | 23.22 | 1068.0 | 88.29 | 700 | $7 \times 2.58$ | 36.60 | 24×3.87 | 282.30 | 72.6 | 27.4 |
| DOVE | 328.50 | 23.55 | 1142.0 | 101.10 | 710 | $7 \times 2.89$ | 45.90 | $26 \times 3.72$ | 282.60 | 68 | 32 |
| SWIFT | 332.00 | 23.66 | 960.5 | 60.68 | 745 | $1 \times 3.38$ | 9.00 | $36 \times 3.38$ | 323.00 | 92.3 | 7.7 |
| KINGBIRD | 340.90 | 23.9 | 1030.0 | 69.67 | 750 | $1 \times 4.78$ | 17.90 | $18 \times 4.78$ | 323.00 | 86.1 | 13.9 |
| - | 343.10 | 25.38 | 1006.1 | 65.79 | 760 | $3 \times 2.25$ | 11.90 | $18 \times 4.84$ | 331.20 | 90.4 | 9.6 |
| PEACOCK | 345.90 | 24.19 | 1159.0 | 95.80 | 740 | $7 \times 2.69$ | 39.80 | $24 \times 4.03$ | 306.10 | 72.5 | 27.5 |
| DUCK | 346.40 | 24.21 | 1158.0 | 99.99 |  | $7 \times 2.69$ | 39.78 | $54 \times 3.69$ | 306.60 | 72.7 | 27.3 |
| EAGLE | 347.90 | 24.22 | 1298.0 | 122.90 | 710 | $7 \times 3.46$ | 65.80 | $30 \times 3.46$ | 282.10 | 59.7 | 40.3 |
| SQUAB | 355.60 | 24.51 | 1236.0 | 108.10 | 745 | $7 \times 3.01$ | 49.80 | $26 \times 3.87$ | 305.80 | 67.9 | 32.1 |
| GOOSE | 364.00 | 24.84 | 1218.0 | 105.32 |  | $7 \times 2.76$ | 41.88 | $54 \times 2.76$ | 322.30 | 72.7 | 27.3 |

DICABS

| Code word | Total cross section | complete conductor diameter | Conductor weight approx. | Calculated breaking load | Current carrying capacity | Construction Steel | Section Steel | Construction on Alu. | Section Alu. | Alu. | Steel |
| :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: |
|  | $\mathrm{mm}^{2}$ | mm | $\mathrm{kg} / \mathrm{km}$ | kN | A | mm | $\mathrm{mm}^{2}$ | mm | $\mathrm{mm}^{2}$ | \% | \% |
| ROCK | 365.00 | 24.84 | 1223.0 | 101.10 | 765 | $7 \times 2.76$ | 41.90 | $24 \times 4.14$ | 323.10 | 72.6 | 27.4 |
| GROSBEAK | 374.30 | 25.15 | 1302.0 | 111.90 | 775 | $7 \times 3.09$ | 52.50 | $26 \times 3.97$ | 321.80 | 67.9 | 32.1 |
| TEAL | 376.60 | 25.24 | 1397.0 | 133.30 | 750 | $19 \times 2.16$ | 69.60 | $30 \times 3.61$ | 307.00 | 60.4 | 39.6 |
| FLAMINGO | 381.00 | 24.21 | 1276.0 | 105.50 | 790 | $7 \times 2.82$ | 43.70 | $24 \times 4.23$ | 337.30 | 72.6 | 27.4 |
| GULL | 381.30 | 25.38 | 1276.0 | 78.66 |  | $7 \times 2.82$ | 43.72 | $54 \times 2.82$ | 337.80 | 72.7 | 27.3 |
| GANNET | 393.20 | 25.76 | 1366.0 | 117.30 | 795 | $7 \times 3.16$ | 54.90 | 26.4 .07 | 338.30 | 68.0 | 32.0 |
| EGRET | 396.10 | 25.90 | 1471.0 | 140.50 | 775 | $19 \times 2.22$ | 73.50 | $30 \times 3.70$ | 322.60 | 60.2 | 39.8 |
| CROW | 409.50 | 26.28 | 1370.0 | 116.88 |  | $7 \times 2.48$ | 86.87 | $54 \times 2.92$ | 262.50 | 52.6 | 47.4 |
| COOT | 413.10 | 26.39 | 1195.0 | 74.75 | 860 | $1 \times 3.77$ | 11.20 | $36 \times 3.77$ | 401.90 | 92.4 | 7.6 |
| STARLING | 421.00 | 26.68 | 1465.0 | 125.90 | 835 | $7 \times 3.28$ | 59.10 | $26 \times 4.21$ | 361.90 | 67.8 | 32.2 |
| TERN | 431.60 | 27.03 | 1336.0 | 97.43 | 875 | $7 \times 2.25$ | 27.80 | $45 \times 3.38$ | 403.80 | 8.30 | 17.0 |
| REDWING | 444.50 | 27.43 | 1651.0 | 153.70 | 840 | $19 \times 2.35$ | 82.40 | $30 \times 3.92$ | 362.10 | 60.2 | 39.8 |
| CUCKOO | 454.50 | 27.74 | 1523.0 | 123.90 | 885 | $7 \times 3.08$ | 52.20 | $24 \times 4.62$ | 402.30 | 72.5 | 27.5 |
| CONDOR | 454.50 | 27.72 | 1523.0 | 124.40 | 885 | $7 \times 3.08$ | 52.20 | $54 \times 3.08$ | 402.30 | 72.6 | 27.5 |
| DRAKE | 468.00 | 28.11 | 1626.0 | 139.60 | 890 | $7 \times 3.45$ | 65.40 | $26 \times 4.44$ | 402.60 | 68.0 | 32.0 |
| RUDDY | 487.20 | 28.74 | 1510.0 | 109.40 | 945 | $7 \times 2.40$ | 31.70 | $14 \times 1.59$ | 455.50 | 82.8 | 17.2 |
| MALLARD | 495.60 | 28.96 | 1840.0 | 171.20 | 900 | $19 \times 2.48$ | 91.80 | $30 \times 4.11$ | 403.80 | 60.3 | 39.7 |
| CATBIRD | 498.10 | 28.98 | 1441.0 | 87.93 | 970 | $1 \times 4.14$ | 13.50 | $36 \times 4.14$ | 484.60 | 92.4 | 7.6 |
| CRANE | 500.60 | 29.11 | 1674.0 | 139.54 |  | $7 \times 3.23$ | 57.36 | $54 \times 3,23$ | 443.10 | 72.7 | 27.3 |
| CANARY | 515.30 | 29.52 | 1725.0 | 140.90 | 955 | $7 \times 3.78$ | 59.10 | $54 \times 3.78$ | 456.20 | 72.6 | 27.4 |
| RAIL | 517.40 | 29.61 | 1603.0 | 116.10 | 980 | $7 \times 2.47$ | 33.60 | $45 \times 3.70$ | 483.80 | 82.9 | 17.1 |
| CARDINAL | 547.30 | 30.42 | 1832.0 | 149.70 | 995 | $7 \times 3.38$ | 62.80 | $54 \times 3.38$ | 484.50 | 72.6 | 27.4 |
| ORTOLAN | 560.20 | 30.81 | 1735.0 | 123.30 | 1030 | $7 \times 2.57$ | 36.30 | $45 \times 3.85$ | 523.90 | 82.9 | 17.1 |
| CURLEW | 590.20 | 31.59 | 1976.0 | 161.40 | 1025 | $7 \times 3.51$ | 67.70 | $54 \times 3.51$ | 522.50 | 72.6 | 27.4 |
| BLUELJAY | 604.40 | 31.98 | 1871.0 | 132.70 | 1060 | $7 \times 2.66$ | 38.90 | $45 \times 4.00$ | 565.50 | 83.0 | 17.0 |
| FINCH | 636.60 | 32.85 | 2133.0 | 174.60 | 1080 | $19 \times 2.19$ | 71.60 | $54 \times 3.65$ | 565.00 | 72.7 | 27.3 |
| BUNTING | 647.60 | 33,12 | 2005.0 | 142.30 | 1110 | $7 \times 2.76$ | 41.80 | $45 \times 4.14$ | 605.80 | 83.0 | 17.0 |
| GRACKLE | 679.70 | 33.97 | 2280.0 | 186.90 | 1125 | $19 \times 2.27$ | 76.90 | $54 \times 3.77$ | 602.80 | 72.6 | 27.4 |
| BITIERN | 689.10 | 34.17 | 2134.0 | 151.70 | 1155 | $7 \times 2.85$ | 44.70 | $45 \times 4.27$ | 644.40 | 82.9 | 17.1 |
| PHEASANT | 726.80 | 35.10 | 2435.0 | 194.10 | 1175 | $19 \times 2.34$ | 81.70 | $54 \times 3.90$ | 645.10 | 72.6 | 27.4 |
| DIPPER | 731.40 | 35.19 | 2265.0 | 160.70 | 1205 | $7 \times 2.93$ | 47.20 | $45 \times 4.40$ | 684.20 | 83.0 | 17.0 |
| MARTIN | 772.10 | 36.17 | 2587.0 | 206.10 | 1225 | $19 \times 2.41$ | 86.70 | $54 \times 4.02$ | 685.40 | 72.8 | 27.2 |
| BOBOLINK | 775.40 | 36.24 | 2400.0 | 170.50 | 1250 | $7 \times 3.02$ | 50.10 | $45 \times 4.53$ | 725.30 | 83.0 | 17.0 |
| NUTHATCH | 817.00 | 37.20 | 2529.0 | 177.60 | 1295 | $7 \times 3.10$ | 52.80 | $45 \times 4.65$ | 764.20 | 83.0 | 17.0 |
| PLOVER | 818.70 | 37.24 | 2743.0 | 218.40 | 1270 | $19 \times 2.48$ | 91.80 | $54 \times 4.14$ | 726.90 | 72.8 | 27.2 |
| PARROT | 863.10 | 38.25 | 2892.0 | 230.50 | 1315 | $19 \times 2.55$ | 97.00 | $54 \times 4.25$ | 766.10 | 72.8 | 27.2 |
| LAPWING | 863.10 | 38.22 | 2671.0 | 187.40 | 1335 | $7 \times 3.18$ | 55.60 | $45 \times 4.78$ | 807.80 | 83.0 | 17.0 |
| FALCON | 908.70 | 39.26 | 3047.0 | 243.10 | 1360 | $19 \times 2.62$ | 102.50 | $51 \times 4.36$ | 806.20 | 72.7 | 27.3 |
| CHUKAR | 976.70 | 40.70 | 3089.0 | 227.70 | 1435 | $19 \times 2.22$ | 73.50 | $84 \times 3.70$ | 903.20 | 80.3 | 19.7 |
| - | 1076.00 | 42.71 | 3222.0 | 208.40 | 1540 | $7 \times 2.85$ | 45.00 | $72 \times 4.27$ | 1031.00 | 87.9 | 12.1 |
| KIWI | 1147.00 | 44.10 | 3430.0 | 221.10 | 1600 | $7 \times 2.94$ | 47.00 | $72 \times 4.41$ | 1100.00 | 88.1 | 11.9 |
| BLUEBIRD | 1182.00 | 44.76 | 3740.0 | 268.30 | 1615 | $19 \times 2.44$ | 89.00 | $84 \times 4.07$ | 1093.00 | 80.3 | 19.7 |
| THRASHER | 1235.00 | 45.79 | 3761.0 | 251.80 | 1670 | $19 \times 2.07$ | 64.00 | $76 \times 4.43$ | 1171.00 | 85.6 | 14.4 |
| JOREE | 134.00 | 47.76 | 4095.0 | 274.50 | 1755 | $19 \times 2.16$ | 70.00 | $76 \times 4.62$ | 1274.00 | 85.4 | 14.0 |

## ALUMINIUM CLAD STEEL STRANDED CONDUCTORS

DIN 48201/8

| Cross Section |  |  |  |  |  |  |  |  |
| :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: |
| Nominal | Actual | No. of <br> wires | Wire <br> diameter | Complete <br> Conductor <br> diameter | Conductor <br> weight <br> appr. | Calculated <br> breaking <br> load | Calculated <br> conductor <br> resistance at <br> $20^{\circ} \mathrm{C}$ | Current <br> carrying <br> capacity |
| $\mathrm{mm}^{2}$ | $\mathrm{~mm}^{2}$ |  | mm | mm | $\mathrm{~kg} / \mathrm{km}$ | kN | $\Omega / \mathrm{km}$ | A |
| 25 | 24.25 | 7 | 2.10 | 6.3 | 162 | 31.56 | 3.546 | 65 |
| 35 | 34.36 | 7 | 2.50 | 7.5 | 229 | 44.72 | 2.499 | 80 |
| 50 | 49.48 | 7 | 3.00 | 9.0 | 330 | 64.40 | 1.736 | 115 |
| 70 | 65.81 | 19 | 2.10 | 10.5 | 441 | 85.65 | 1.313 | 135 |
| 95 | 93.27 | 19 | 2.50 | 12.5 | 626 | 121.39 | 0.925 | 170 |
| 120 | 116.99 | 37 | 2.80 | 14.0 | 785 | 152.26 | 0.737 | 195 |
| 150 | 147.11 | 37 | 2.25 | 15.7 | 990 | 191.46 | 0.587 | 225 |
| 185 | 181.62 | 37 | 2.50 | 17.5 | 1221 | 236.38 | 0.476 | 255 |
| 240 | 242.54 | 61 | 2.25 | 20.2 | 1635 | 299.05 | 0.357 | 310 |
| 300 | 299.43 | 61 | 2.50 | 22.5 | 2017 | 369.20 | 0.289 | 355 |

## ALL ALUMINIUM ALLOY CONDUCTORS STEEL REINFORCED (AACSR)

NFC 34-125

| Code word | Total <br> cross <br> section | Complete <br> conductor <br> diameter | Conductor <br> weight <br> approx. | Calculated <br> breaking <br> load | Electrical <br> resistance <br> at20 | Construction <br> Steel | Section <br> Steel | Construction <br> AAA | Section <br> AAA | AIMGsi | Steel |
| :--- | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: |
| $\mathrm{mm}^{2}$ | mm | $\mathrm{~kg} / \mathrm{km}$ | kN | $\Omega / \mathrm{km}$ | mm | $\mathrm{mm}^{2}$ | mm | $\mathrm{~mm}^{2}$ | $\%$ | $\%$ |  |
| PHLOX | 37.7 | 8.30 | 155 | 23.60 | 1.170 | $3 \times 2.00$ | 9.42 | $9 \times 2.00$ | 28.27 | 50 | 50 |
| PHLOX | 59.7 | 10.00 | 276 | 45.60 | 0.880 | $7 \times 2.00$ | 21.99 | $12 \times 2.00$ | 37.70 | 37.6 | 62.4 |
| PHLOX | 75.5 | 11.25 | 348 | 57.70 | 0.695 | $7 \times 2.25$ | 27.83 | $12 \times 2.25$ | 47.71 | 37.6 | 62.4 |
| PHLOX | 94.1 | 12.80 | 481 | 80.35 | 0.642 | $19 \times 1.68$ | 42.12 | $15 \times 2.10$ | 51.95 | 29.7 | 70.3 |
| PHLOX | 116.2 | 14.00 | 636 | 108.15 | 0.580 | $19 \times 2.00$ | 59.69 | $18 \times 2.00$ | 56.55 | 24.4 | 75.6 |
| PHLOX | 147.1 | 15.75 | 802 | 136.85 | 0.466 | $19 \times 2.25$ | 75.54 | $18 \times 2.25$ | 71.57 | 24.5 | 75.5 |
| PASTEL | 147.1 | 15.75 | 547 | 81.85 | 0.279 | $7 \times 2.25$ | 27.83 | $30 \times 2.25$ | 119.28 | 59.9 | 40.1 |
| PHLOX | 181.6 | 17.50 | 990 | 168.95 | 0.378 | $19 \times 2.50$ | 93.27 | $18 \times 2.50$ | 88.36 | 24.5 | 75.5 |
| PASTEL | 181.6 | 17.50 | 675 | 101.20 | 0.227 | $7 \times 2.50$ | 34.36 | $30 \times 2.50$ | 147.26 | 59.9 | 40.1 |
| PHLOX | 228.0 | 19.60 | 1244 | 212.00 | 0.300 | $19 \times 2.80$ | 116.99 | $18 \times 2.80$ | 110.83 | 24.5 | 75.5 |
| PASTEL | 228.0 | 19.60 | 848 | 126.80 | 0.180 | $7 \times 2.80$ | 43.10 | $30 \times 2.80$ | 184.72 | 59.8 | 40.2 |
| PHLOX | 288.0 | 22.50 | 1570 | 268.00 | 0.237 | $19 \times 3.15$ | 148.07 | $18 \times 3.15$ | 140.28 | 24.5 | 75.5 |
| PASTEL | 288.0 | 22.05 | 1074 | 160.50 | 0.142 | $7 \times 3.15$ | 54.55 | $30 \times 3.15$ | 233.80 | 59.8 | 40.2 |
| PASTEL | 299.0 | 22.05 | 1320 | 208.75 | 0.162 | $19 \times 2.50$ | 93.27 | $42 \times 2.50$ | 206.17 | 42.9 | 57.1 |
| PHLOX | 376.0 | 25.20 | 2211 | 389.60 | 0.225 | $37 \times 2.80$ | 227.83 | $24 \times 2.80$ | 147.78 | 18.4 | 81.6 |
| PASTEL | 412.0 | 26.40 | 1593 | 238.30 | 0.103 | $19 \times 2.40$ | 85.95 | $32 \times 3.60$ | 325.72 | 56.1 | 43.9 |
| PETUNIA | 612.0 | 32.20 | 2241 | 326.90 | 0.065 | $19 \times 2.65$ | 104.79 | $20 \times 4.24$ | 507.10 | 62.1 | 37.9 |
| PETUNIA | 865.0 | 38.10 | 3174 | 460.00 | 0.047 | $19 \times 3.15$ | 148.06 | $66 \times 3.72$ | 717.33 | 62.1 | 37.9 |
| POLYGO NUM | 1185.0 | 44.70 | 4475 | 663.85 | 0.035 | $37 \times 2.80$ | 227.82 | $54 \times 2.80$ | $66 \times 3.47$ | 956.66 | 58.7 |
|  |  |  |  |  |  |  |  |  |  |  |  |

## ALL ALUMINIUM ALLOY CONDUCTORS STEEL REINFORCED (AACSR) DIN 48206

| Nominal Cross section | Total cross section | Complete conductor diameter | Conductor weight approx. | Calculated breaking load | $\begin{array}{\|c\|} \hline \text { Electrical } \\ \text { resistance at } \\ 20^{\circ} \mathrm{C} \end{array}$ | Construction Steel | Section Steel | Construction AAA | Section AAA | AAAC | Steel |
| :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: |
|  | $\mathrm{mm}^{2}$ | mm | kg/km | kN | $\Omega / \mathrm{km}$ | mm | $\mathrm{mm}^{2}$ | mm | $\mathrm{mm}^{2}$ | \% | \% |
| 16/2.5 | 17.85 | 5.40 | 62 | 7.70 | 2.181 | $1 \times 1.80$ | 2.55 | 6X1.80 | 15.30 | 67.8 | 32.2 |
| 25/4 | 27.80 | 6.75 | 96 | 12.00 | 1.396 | $1 \times 2.25$ | 4.00 | $6 \times 2.25$ | 23.80 | 68.1 | 31.9 |
| 35/6 | 40.00 | 8.10 | 140 | 17.15 | 0.969 | $1 \times 2.70$ | 5.70 | 6×2.70 | 34.30 | 67.3 | 32.7 |
| 44/32 | 75.70 | 11.20 | 374 | 51.50 | 0.763 | $7 \times 2.40$ | 31.70 | $14 \times 2.00$ | 44.00 | 32.3 | 67.7 |
| 50/8 | 56.30 | 9.60 | 196 | 24.15 | 0.690 | $1 \times 3.20$ | 8.00 | $6 \times 3.20$ | 48.30 | 67.8 | 32.2 |
| 50/30 | 81.00 | 11.70 | 378 | 51.20 | 0.655 | $7 \times 2.33$ | 29.80 | $12 \times 2.83$ | 51.20 | 37.2 | 62.8 |
| 70/12 | 81.30 | 11.70 | 283 | 34.70 | 0.479 | $7 \times 1.44$ | 11.40 | $26 \times 2.85$ | 69.90 | 67.8 | 32.2 |
| 94/22 | 116.20 | 14.00 | 432 | 54.80 | 0.356 | $7 \times 2.00$ | 22.00 | $30 \times 2.00$ | 94.20 | 59.9 | 40.1 |
| 95/15 | 109.70 | 13.60 | 382 | 46.80 | 0.355 | $7 \times 1.67$ | 15.30 | $26 \times 2.15$ | 94.40 | 67.9 | 32.2 |
| 95/34 | 131.10 | 14.90 | 537 | 70.55 | 0.347 | $7 \times 2.50$ | 34.40 | 36×85 | 96.80 | 49.5 | 50.5 |
| 95/55 | 152.80 | 16.00 | 713 | 96.85 | 0.347 | $7 \times 3.20$ | 56.30 | $12 \times 3.20$ | 96.50 | 37.2 | 62.8 |
| 105/75 | 181.50 | 17.50 | 894 | 122.80 | 0.318 | $19 \times 2.25$ | 75.50 | $14 \times 3.10$ | 105.70 | 32.5 | 67.5 |
| 120/20 | 141.40 | 15.50 | 493 | 60.35 | 0.276 | $7 \times 1.90$ | 19.80 | $26 \times 2.44$ | 121.60 | 67.7 | 32.3 |
| 120/42 | 160.40 | 16.50 | 654 | 85.80 | 0.276 | $7 \times 2.75$ | 41.60 | 36X2.05 | 118.80 | 49.9 | 50.1 |
| 120/70 | 193.30 | 18.00 | 903 | 122.60 | 0.274 | $7 \times 3.60$ | 71.30 | 12X3.60 | 122.00 | 37.1 | 62.9 |
| 125/30 | 157.70 | 16.30 | 590 | 74.20 | 0.262 | $7 \times 2.33$ | 29.80 | $30 \times 2.33$ | 127.90 | 59.5 | 40.5 |
| 150/25 | 173.10 | 17.10 | 604 | 73.85 | 0.225 | $7 \times 2.10$ | 24.20 | $26 \times 2.70$ | 148.90 | 67.7 | 32.2 |
| 150/53 | 202.40 | 18.50 | 827 | 108.55 | 0.224 | $7 \times 3.10$ | 52.80 | 36X2.30 | 149.60 | 49.7 | 50.3 |
| 170/40 | 211.90 | 18.90 | 792 | 99.90 | 0.195 | $7 \times 2.70$ | 40.10 | $30 \times 2.70$ | 171.80 | 59.6 | 40.4 |
| 185/30 | 213.60 | 19.00 | 744 | 91.00 | 0.182 | $7 \times 2.33$ | 29.80 | $26 \times 3.00$ | 183.80 | 67.8 | 32.2 |
| 210/35 | 243.20 | 20.30 | 848 | 103.90 | 0.160 | $7 \times 2.68$ | 39.50 | $26 \times 3.45$ | 243.00 | 67.9 | 32.1 |
| 210/50 | 261.60 | 21.00 | 978 | 123.35 | 0.158 | $7 \times 3.00$ | 49.50 | $30 \times 3.00$ | 212.10 | 59.6 | 40.4 |
| 230/30 | 260.70 | 21.00 | 873 | 105.10 | 0.145 | $7 \times 2.33$ | 29.80 | 24×3.50 | 230.90 | 72.6 | 27.4 |
| 240/40 | 282.50 | 21.90 | 983 | 120.50 | 0.138 | $7 \times 2.49$ | 34.10 | $26 \times 3.20$ | 243.00 | 67.7 | 32.3 |
| 257/60 | 316.50 | 23.10 | 1177 | 149.20 | 0.131 | $7 \times 3.30$ | 59.90 | $30 \times 3.30$ | 256.60 | 59.9 | 40.1 |
| 265/35 | 297.80 | 22.40 | 998 | 120.20 | 0.127 | $7 \times 2.49$ | 34.10 | $24 \times 3.74$ | 263.70 | 72.6 | 27.4 |
| 300/50 | 353.70 | 24.50 | 1232 | 151.00 | 0.110 | $7 \times 3.00$ | 49.50 | $26 \times 3.86$ | 304.20 | 67.8 | 32.2 |
| 305/40 | 344.10 | 24.10 | 1155 | 136.12 | 0.108 | $7 \times 2.68$ | 39.49 | $54 \times 2.68$ | 304.62 | 72.4 | 27.6 |
| 340/30 | 369.10 | 25.00 | 1174 | 134.94 | 0.099 | $7 \times 2.33$ | 29.85 | $48 \times 3.00$ | 339.29 | 79.4 | 20.6 |
| 340/110 | 450.00 | 27.70 | 1799 | 233.55 | 0.098 | $19 \times 2.70$ | 108.80 | $78 \times 2.36$ | 341.20 | 52.1 | 47.9 |
| 380/50 | 431.20 | 27.00 | 1448 | 170.56 | 0.087 | $7 \times 3.00$ | 49.48 | $54 \times 3.00$ | 381.70 | 72.4 | 27.6 |
| 385/35 | 420.10 | 26.70 | 1336 | 153.69 | 0.085 | $7 \times 2.49$ | 34.09 | $48 \times 3.20$ | 386.04 | 79.4 | 20.6 |
| 435/55 | 490.60 | 28.80 | 1647 | 194.06 | 0.076 | $7 \times 3.20$ | 56.30 | $54 \times 3.20$ | 434.29 | 72.4 | 27.6 |
| 450/40 | 488.20 | 28.70 | 1553 | 178.48 | 0.074 | $7 \times 2.68$ | 39.49 | $48 \times 3.45$ | 448.71 | 79.3 | 20.7 |
| 490/65 | 553.80 | 30.60 | 1860 | 219.07 | 0.068 | $7 \times 3.40$ | 63.55 | $54 \times 3.40$ | 490.28 | 72.4 | 27.6 |
| 550/70 | 620.90 | 32.40 | 2085 | 245.60 | 0.060 | $7 \times 3.60$ | 71.25 | $54 \times 3.60$ | 549.65 | 72.4 | 27.6 |
| 560/50 | 611.20 | 32.20 | 1943 | 223.48 | 0.059 | $7 \times 3.00$ | 49.48 | $48 \times 3.86$ | 561.70 | 79.4 | 20.6 |
| 680/85 | 764.50 | 36.00 | 2564 | 300.84 | 0.048 | $19 \times 2.40$ | 85.95 | $54 \times 4.00$ | 678.58 | 72.7 | 27.3 |

## ALUMINIUM WIRES AND ALUMINIUM STRANDED CONDUCTORS

DIN 48203 Part - 5

Table 1. Fixed values

| Number of wires | linear force due to mass per unit cross sectional (QLK) N/m $\mathrm{mm}^{2}$ | Coefficient of linear expansion $1 / K$ | Practical modulus of elasticity |
| :---: | :---: | :---: | :---: |
| 7 | 0.0275 | $23.10^{-6}$ | 60 |
| 19 |  |  | 57 |
| 37 |  |  | 57 |
| 61 |  |  | 55 |
| 91 |  |  | 55 |

Table 2. Stranding constants

| Number of wires | Stranding constants for |  |
| :---: | :---: | :---: |
|  | Mass | Electrical resistance |
| 7 | 7.091 | 1447 |
| 19 | 19.34 | 0.05357 |
| 37 | 37.74 | 0.02757 |
| 61 | 62.35 | 0.01676 |
| 91 | 93.26 | 0.01126 |


| Material | Wires | Stranded Conductors | Technical delivery conditions |  | IEC |
| :---: | :---: | :---: | :---: | :---: | :---: |
|  |  |  | New | Previous |  |
| Copper | DIN 48200 Part 1 | DIN 408201 Part 1 | DIN 48203 Part 1 | DIN 48202 Part 2 | . |
| Wrought copper alloys (Bz) | DIN 48200 Part 2 | DIN 408201 Part 2 | DIN 48203 Part 2 | DIN 48202 Part 2 | . |
| Steel | DIN 48200 Part 3 | DIN 408201 Part 3 | DIN 48203 Part 3 | DIN 48202 Part 1 | . |
| Aluminium | DIN 48200 Part 5 | DIN 408201 Part 5 | DIN 48203 Part 5 | DIN 48202 Part 1 | 207 |
| E-AlMgsi | DIN 48200 Part 6 | DIN 408201 Part 6 | DIN 48203 Part 6 | DIN 48202 Part 3 | 208 |
| Copper covered steel | DIN 48200 Part 7 | DIN 408201 Part 7 | DIN 48203 Part 7 | DIN 48202 Part 5 | . |
| Aluminium-clad steel | DIN 48200 Part 8 | DIN 408201 Part 8 | DIN 48203 Part 8 | DIN 48202 Part 1*) | . |
| Aluminium reinforced steel | . | DIN 48204 | DIN 48203 Part 11 | DIN 48202 Part 1 | 209 |
| E-AlMgsi reinforced steel | . | DIN 48206 | DIN 48203 Part 12 | DIN 48202 Part 4 | 210 |
| *) January 1975 draft |  |  |  |  |  |

## WIRES FOR STRANDED CONDUCTORS

## ALUMINIUM WIRES

DIN 48200 PART - 5

| Nominal diameter ${ }^{\prime}$ (mm) |  | Wire cross section ( $\mathrm{mm}^{2}$ ) | Tensile strength ( $\mathrm{N} / \mathrm{mm}^{2}$ ) |  | Resistance per unit | $\begin{gathered} \text { Mass }(2.7 \\ \left.\mathrm{kg} / \mathrm{dm}^{3}\right) \text { in } \mathrm{kg} \end{gathered}$ |
| :---: | :---: | :---: | :---: | :---: | :---: | :---: |
|  | Permissible deviation |  | Before Standing (min) | After Stranding $(\mathrm{min})$ | ( W/km) min | $(\mathrm{Kg} / \mathrm{km}) \approx$ |
| 1.50 | $\pm 0.03$ | 1.77 | 193 | 183 | 15.99 | 4.8 |
| 1.75 |  | 2.41 | 188 | 179 | 11.75 | 6.5 |
| 2.00 |  | 3.14 | 184 | 176 | 9.00 | 8.5 |
| 2.25 |  | 3.98 | 181 | 172 | 7.11 | 10.7 |
| 2.50 |  | 4.91 | 177 | 168 | 5.76 | 13.3 |
| 2.75 |  | 5.94 | 173 | 164 | 4.76 | 16.0 |
| 3.00 |  | 7.07 | 169 | 160 | 4.00 | 19.1 |
| 3.25 | $\pm 0.04$ | 8.30 | 166 | 157 | 3.41 | 22.4 |
| 3.50 |  | 9.62 | 164 | 156 | 2.94 | 26.0 |
| 3.75 |  | 11.04 | 162 | 154 | 2.56 | 29.8 |
| 4.00 |  | 12.57 | 160 | 152 | 2.25 | 33.9 |
| 4.25 |  | 14.19 | 160 | 152 | 1.99 | 38.3 |
| 4.50 |  | 15.90 | 159 | 151 | 1.78 | 42.9 |

1. Intermediate values are permitted. In this case, the permissible deviations for the next largest diameter given in the table shall apply.
2. For wire with intermediate diameters, the values given in the table for the next largest diameter shall apply.
3. The resistance per unit length is calculated for the nominal wire cross section, taking the specified minimum conductivity as the basis. The values shall be converted accordingly for plus or minus deviations from the wire dimeter.

## Wires for stranded Conductors

Steel Wires
DIN 48200 Part 3
Table-2

| Gauge length | At an initial stress, in $\mathrm{N} / \mathrm{mm}^{2}$ |  |  |
| :---: | :---: | :---: | :---: |
| in mm | 100 | 200 | 300 |
| 50 | 0.025 mm | 0.05 mm | 0.075 mm |
| 200 | 0.100 mm | 0.20 mm | 0.300 mm |
| 250 | 0.125 mm | 0.25 mm | 0.375 mm |

A density of $7.8 \mathrm{~kg} / \mathrm{dm} 3$ shall be used as the basis for calculating the mass. Zinc coating
Table - 3

| Nominal diameter, in mm | Mass per unit area g/m² | Number of <br> inersions ${ }^{2}$ |
| :---: | :---: | :---: |
| 1.35 to 1.55 | 190 | 2 |
| 1.56 to 1.75 | 200 | 2 |
| 1.76 to 2.24 | 210 | $2^{1 / 5}$ |
| 2.25 to 2.74 | 230 | 3 |
| 2.75 to 3.05 | 240 | 3 |
| 3.06 to 3.49 | 250 | $3^{3 / 5}$ |
| 3.50 to 4 | 275 | $3^{1 / 2}$ |
| over 4 |  | 4 |
| shall |  |  |

1. The values shall apply for the final (galvanized) condition.
2. Testing shall be carried out as specified in DIN 48202 Part 3.

Finish drawn and galvanized.
Table - 1

| Nominal Diameter (mm) |  | Steel I | Steel IITensile Strength |  | Steel III |  |  | Steel VI |  |  |
| :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: |
|  |  | Tensile Strength |  |  | Tensile stress at 1\% extension ${ }^{1}$ $\mathrm{N} / \mathrm{mm}^{2}$ (min) | Tensile Strength |  | Tensile <br> stress at <br> $1 \%$ <br> extension ${ }^{1}$ <br> $\mathrm{~N} / \mathrm{mm}^{2}$ <br> $(\mathrm{~min})$ | Tensile Strength |  |
|  | Permissible deviation | $\mathrm{N} / \mathrm{mm}^{2}$ | Before stranding $\mathrm{N} / \mathrm{mm}^{2}$ (min) | After stranding $\mathrm{N} / \mathrm{mm}^{2}$ (min) |  | Before stranding $\mathrm{N} / \mathrm{mm}^{2}$ | After stranding $\mathrm{N} / \mathrm{mm}^{2}$ $(\mathrm{~min})$ |  | Before stranding $\mathrm{N} / \mathrm{mm}^{2}$ | After stranding $\mathrm{N} / \mathrm{mm}^{2}$ $(\mathrm{~min})$ |
| 1.35 to 1.75 | $\pm 0.035$ | 390 | 690 | 650 | 1180 | $\begin{gathered} 1310 \text { to } \\ 1520 \end{gathered}$ | 1250 | 1310 | $\begin{gathered} 1570 \text { to } \\ 1810 \end{gathered}$ |  |
| 1.76 to 2.74 | $\pm 0.04$ |  |  |  |  |  |  | 1270 |  |  |
| 2.75 to 3.49 | $\pm 0.05$ | 390 | 690 | 650 | 1140 |  | 1250 | 1250 |  | 1490 |
| 3.5 to 4.95 | $\pm 0.06$ |  |  |  | 1100 |  |  | 1180 |  |  |

1) The intial stress prior to the application of the exten someter shall be

For nominal diameters up to $2.25 \mathrm{~mm}: 100 \mathrm{~N} / \mathrm{mm}^{2}$ : for nominal diameters over 2.25 upto $3 \mathrm{~mm}: 200 \mathrm{~N} / \mathrm{mm}^{2}$
For nominal diameters over $3 \mathrm{~mm}: 300 \mathrm{~N} / \mathrm{mm}^{2}$.
The extensometer reading at this initial stress is the starting point for the measurement of the $1 \%$ extension and shall have the value given in the following table.

## STEEL REINFORCED ALUMINIUM STRANDED CONDUCTORS

DIN 48204

## Conductor DIN 48 204-95/15-AL/St

Table 1.
Dimensions, mechanical and electrical values

| 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 |
| :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: |
| Nominal cross section | Required cross section | Cross section ratio Alu./St. | Conductor diameter | Mass ${ }^{1}$ $\mathrm{Kg} / \mathrm{km}$ | Theoretical breaking force ${ }^{2}$ | Resistance per unit length | Current carrying capacity ${ }^{3}$ |
| $\mathrm{mm}^{2}$ | $\mathrm{mm}^{2}$ | $\approx$ | mm | $\approx$ | kN | $\Omega / \mathrm{km}$ | A |
| 16/2.5 | 17.8 | 6 | 5.4 | 62 | 5.81 | 1.8793 | 105 |
| 25/4 | 27.8 | 6 | 6.8 | 97 | 9.02 | 1.2028 | 140 |
| 35/6 | 40.1 | 6 | 8.1 | 140 | 12.7 | 0.8353 | 170 |
| 44/32 | 75.7 | 1.4 | 11.2 | 373 | 45.46 | 0.6573 | . |
| 50/8 | 56.3 | 6 | 9.6 | 196 | 17.18 | 0.5946 | 210 |
| 50/30 | 81.0 | 1.7 | 11.7 | 378 | 44.28 | 0.5644 | - |
| 70/12 | 81.3 | 6 | 11.7 | 284 | 26.31 | 0.4130 | 290 |
| 95/15 | 109.7 | 6 | 13.6 | 383 | 35.17 | 0.3058 | 350 |
| 95/55 | 152.8 | 1.7 | 16.0 | 714 | 80.20 | 0.2992 | - |
| 105/75 | 181.2 | 1.4 | 17.5 | 899 | 106.69 | 0.2736 | - |
| 120/20 | 141.4 | 6 | 15.5 | 494 | 44.94 | 0.2374 | 410 |
| 120/70 | 193.4 | 1.7 | 18.0 | 904 | 98.16 | 0.2364 | . |
| 125/30 | 157.8 | 4.3 | 16.3 | 590 | 57.86 | 0.2259 | 425 |
| 150/25 | 173.1 | 6 | 17.1 | 604 | 54.37 | 0.1939 | 470 |
| 170/40 | 211.9 | 4.3 | 18.9 | 794 | 77.01 | 0.1682 | 520 |
| 185/30 | 213.6 | 6 | 19.0 | 744 | 66.28 | 0.1571 | 535 |
| 210/35 | 243.2 | 6 | 20.3 | 848 | 74.94 | 0.1380 | 590 |
| 210/50 | 261.5 | 4.3 | 21.0 | 979 | 92.25 | 0.1363 | 610 |
| 230/30 | 260.8 | 7.7 | 21.0 | 874 | 73.09 | 0.1249 | 630 |
| 240/40 | 282.5 | 6 | 21.8 | 985 | 86.46 | 0.1188 | 645 |
| 265/35 | 297.8 | 7.7 | 22.4 | 998 | 82.94 | 0.1094 | 680 |
| 300/50 | 353.7 | 6 | 24.5 | 1233 | 105.09 | 0.0949 | 740 |
| 305/40 | 344.1 | 7.7 | 24.1 | 1155 | 99.30 | 0.0949 | 740 |
| 340/30 | 369.1 | 11.3 | 25.0 | 1174 | 92.56 | 0.0851 | 790 |
| 380/50 | 431.2 | 7.7 | 27.0 | 1448 | 120.91 | 0.0757 | 840 |
| 385/35 | 420.1 | 11.3 | 26.7 | 1336 | 104.31 | 0.0748 | 850 |
| 435/55 | 490.6 | 7.7 | 28.8 | 1647 | 136.27 | 0.0666 | 900 |
| 450/40 | 488.2 | 11.3 | 28.7 | 1553 | 120.19 | 0.0644 | 920 |
| 490/65 | 553.8 | 7.7 | 30.6 | 1860 | 152.85 | 0.0590 | 960 |
| 495/35 | 528.4 | 14.5 | 29.9 | 1636 | 120.31 | 0.0584 | 985 |
| 510/45 | 555.8 | 11.3 | 30.7 | 1770 | 134.33 | 0.0566 | 995 |
| 550/70 | 620.9 | 7.7 | 32.4 | 2085 | 167.42 | 0.0526 | 1020 |
| 560/50 | 611.2 | 11.3 | 32.2 | 1943 | 146.28 | 0.0514 | 1040 |
| 570/40 | 610.7 | 14.5 | 32.2 | 1889 | 137.98 | 0.0506 | 1050 |
| 650/45 | 698.8 | 14.5 | 34.4 | 2163 | 155.52 | 0.0442 | 1120 |
| 680/85 | 764.5 | 7.7 | 36.0 | 2564 | 209.99 | 0.0426 | 1150 |
| 1045/45 | 1090.9 | 23.1 | 43.0 | 3249 | 217.87 | 0.0277 | 1580 |

## STEEL REINFORCED ALUMINIUM STRANDED CONDUCTORS

DIN 48204

Table 2 Construction of Conductor

| 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 |
| :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: |
|  | Aluminium parts |  |  |  | Steel parts |  |  |  |
| Nominal cross section | WIRE |  | OUT SIDE LAYER |  | WIRES |  | Core |  |
| $\mathrm{mm}^{2}$ | Number | Diameter ( mm ) | Number of wire layers | Cross section ( $\mathrm{mm}^{2}$ ) | Number | $\begin{aligned} & \text { Diameter } \\ & (\mathrm{mm}) \end{aligned}$ | Diameters (mm) | Cross section ( $\mathrm{mm}^{2}$ ) |
| 16/2.5 | 6 | 1.80 | 1 | 15.27 | 1 | 1.80 | - | 2.54 |
| 25/4 | 6 | 2.25 | 1 | 23.86 | 1 | 2.25 | , | 3.98 |
| 35/6 | 6 | 2.70 | 1 | 34.35 | 1 | 2.70 | - | 5.73 |
| 44/32 | 14 | 2.00 | 1 | 43.98 | 7 | 2.40 | 7.20 | 31.67 |
| 50/8 | 6 | 3.20 | 1 | 48.25 | 1 | 3.20 | - | 8.04 |
| 50/30 | 12 | 2.33 | 1 | 51.17 | 7 | 2.33 | 6.99 | 29.85 |
| 70/12 | 26 | 1.85 | 2 | 69.89 | 7 | 1.44 | 4.32 | 11.40 |
| 95/15 | 26 | 2.15 | 2 | 94.39 | 7 | 1.67 | 5.01 | 15.33 |
| 95/55 | 12 | 3.20 | 1 | 96.51 | 7 | 3.20 | 9.60 | 56.30 |
| 105/75 | 14 | 3.10 | 1 | 105.67 | 19 | 2.25 | 11.25 | 75.55 |
| 120/20 | 26 | 2.44 | 2 | 121.57 | 7 | 1.90 | 5.70 | 19.85 |
| 120/70 | 12 | 3.60 | 1 | 122.15 | 7 | 3.60 | 10.80 | 71.25 |
| 125/30 | 30 | 2.33 | 2 | 127.92 | 7 | 2.33 | 6.99 | 29.85 |
| 150/25 | 26 | 2.70 | 2 | 148.86 | 7 | 2.10 | 6.31 | 24.25 |
| 170/40 | 30 | 2.70 | 2 | 171.77 | 7 | 2.70 | 8.10 | 40.08 |
| 185/30 | 26 | 3.00 | 2 | 183.78 | 7 | 2.33 | 6.99 | 29.85 |
| 210/35 | 26 | 3.20 | 2 | 209.10 | 7 | 2.49 | 7.74 | 34.09 |
| 210/50 | 30 | 3.00 | 2 | 212.06 | 7 | 3.00 | 9.00 | 49.48 |
| 230/30 | 24 | 3.50 | 2 | 230.91 | 7 | 2.33 | 6.99 | 29.85 |
| 240/40 | 26 | 3.45 | 2 | 243.05 | 7 | 2.68 | 8.04 | 39.49 |
| 265/35 | 24 | 3.74 | 2 | 263.66 | 7 | 2.49 | 7.47 | 34.09 |
| 300/50 | 26 | 3.86 | 2 | 304.26 | 7 | 3.00 | 9.00 | 49.48 |
| 305/40 | 54 | 2.68 | 3 | 304.62 | 7 | 2.68 | 8.04 | 39.49 |
| 340/30 | 48 | 3.00 | 3 | 339.29 | 7 | 2.33 | 6.99 | 29.85 |
| 380/50 | 54 | 3.00 | 3 | 381.70 | 7 | 3.00 | 9.00 | 49.48 |
| 385/35 | 48 | 3.20 | 3 | 386.04 | 7 | 2.49 | 7.47 | 34.09 |
| 435/55 | 54 | 3.20 | 3 | 434.29 | 7 | 3.20 | 9.60 | 56.30 |
| 450/40 | 48 | 3.45 | 3 | 448.71 | 7 | 2.68 | 8.04 | 39.49 |
| 490/65 | 54 | 3.40 | 3 | 490.28 | 7 | 3.40 | 10.20 | 63.55 |
| 495/35 | 45 | 3.74 | 3 | 494.36 | 7 | 2.49 | 7.47 | 34.09 |
| 510/45 | 48 | 3.68 | 3 | 510.54 | 7 | 2.87 | 8.61 | 45.28 |
| 550/70 | 54 | 3.60 | 3 | 549.65 | 7 | 3.60 | 10.80 | 71.25 |
| 560/50 | 48 | 3.86 | 3 | 561.70 | 7 | 3.00 | 9.00 | 49.48 |
| 570/40 | 45 | 4.02 | 3 | 571.16 | 7 | 2.68 | 8.04 | 39.49 |
| 650/45 | 45 | 4.30 | 3 | 653.49 | 7 | 2.87 | 8.61 | 45.28 |
| 680/85 | 54 | 4.00 | 3 | 678.58 | 19 | 2.40 | 12.00 | 85.95 |
| 1045/45 | 72 | 4.30 | 4 | 1045.58 | 7 | 2.87 | 8.61 | 45.28 |

Table 3 Lay Ratio for Steel wires

| 1 | 2 | 3 | 4 | 5 |
| :---: | :---: | :---: | :---: | :---: |
| Number of <br> wires in <br> conductor | 1st layer |  |  | Lay Ratio |
|  | $\min$ | $\max$ | $\min$ | $\max$ |
|  | 2nd layer |  |  |  |
| 7 | 13 | 28 |  | $\cdot$ |
| 19 | 13 | 28 | 12 | 24 |

Table 4 Lay ratio for Aluminium wires

| 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 |
| :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: |
| Number of | Lay Ratio |  |  |  |  |  |  |  |
| wires in | 1st Layer |  | 2nd Layer |  | 3rd Layer |  | 4th Layer |  |
| conductor | min | max | min | max | min | max | min | max |
| 6 | 10 | 14 | . | . | . | - | . | - |
| 12 |  |  |  |  |  |  |  |  |
| 14 |  |  |  |  |  |  |  |  |
| 24 | 10 | 16 | 10 | 14 | - | - | - | - |
| 26 |  |  |  |  |  |  |  |  |
| 30 |  |  |  |  |  |  |  |  |
| 45 | 10 | 17 | 10 | 16 | 10 | 14 | . | - |
| 48 |  |  |  |  |  |  |  |  |
| 54 |  |  |  |  |  |  |  |  |
| 72 | 10 | 17 | 10 | 16 | 10 | 15 | 10 | 14 |

Table 5
Aluminium parts
Proportion of Aluminium

| Ratio of cross-sectional area of <br> Aluminium to Steel (Alu./St.) $\approx$ | Proportion by mass of <br> Aluminium to total mass \% |
| :---: | :---: |
| 1.4 | 32.5 |
| 1.7 | 37.3 |
| 4.3 | 59.8 |
| 6 (single-layer) | 67.3 |
| 6 (multi-layer) | 68.0 |
| 7.7 | 72.8 |
| 11.3 | 79.7 |
| 14.5 | 83.4 |
| 23.1 | 88.9 |

## STEEL WIRES AND STEEL STRANDED CONDUCTORS

 DIN 48203 Part 3Table 1. Fixed values for steels I to VI

$\left.$| Number of |
| :---: | :---: | :---: | :---: |
| wires | | Linear force |
| :---: |
| due to mass |
| per unit cross |
| section (QLK) |
| $\mathrm{N} / \mathrm{m} \cdot \mathrm{mm}^{2}$ | | Coefficient of |
| :---: |
| linear |
| expansion |
| $1 / \mathrm{K}$ |$\quad$| Practical |
| :---: |
| modulus of |
| elasticity |
| $\mathrm{kN} / \mathrm{mm}^{2}$ | \right\rvert\,

Table 2. Stranding Constants

| Number of <br> wires | Stranding constants for mass |
| :---: | :---: |
| 7 | 7.091 |
| 19 | 19.34 |


| Material | Wires | Stranded Conductors | Technical delivery conditions |  | IEC |
| :---: | :---: | :---: | :---: | :---: | :---: |
|  |  |  | New | Previous |  |
| Copper | DIN 48200 Part 1 | DIN 408201 Part 1 | DIN 48203 Part 1 | DIN 48202 Part 2 | . |
| Wrought Copper Alloys (Bz) | DIN 48200 Part 2 | DIN 408201 Part 2 | DIN 48203 Part 2 | DIN 48202 Part 2 | - |
| Steel | DIN 48200 Part 3 | DIN 408201 Part 3 | DIN 48203 Part 3 | DIN 48202 Part 1 | - |
| Aluminium | DIN 48200 Part 5 | DIN 408201 Part 5 | DIN 48203 Part 5 | DIN 48202 Part 1 | 207 |
| E-AlMgsi | DIN 48200 Part 6 | DIN 408201 Part 6 | DIN 48203 Part 6 | DIN 48202 Part 3 | 208 |
| Copper covered steel | DIN 48200 Part 7 | DIN 408201 Part 7 | DIN 48203 Part 7 | DIN 48202 Part 5 | - |
| Aluminium-clad steel | DIN 48200 Part 8 | DIN 408201 Part 8 | DIN 48203 Part 8 | DIN 48202 Part 1*) | - |
| Aluminium reinforced steel | $\checkmark$ | DIN 48204 | DIN 48203 Part 11 | DIN 48202 Part 1 | 209 |
| E-AlMgsi reinforced steel | - | DIN 48206 | DIN 48203 Part 12 | DIN 48202 Part 4 | 210 |
| *) January 1975 draft |  |  |  |  |  |

## WIRES AND STRANDED CONDUCTORS

Steel-reinforced Aluminium Stranded Conductors
Technical delivery conditions
Table 1. Properties of stranded conductor

| Approximate ratio of Aluminium/Steel cross-sectional areas | Number of wires Alu./St. | Mass per unit length and crosssectional area. | Coefficient of linear thermal expansion | Modulus of elasticity |
| :---: | :---: | :---: | :---: | :---: |
| $\approx$ | Alu./St. | $\mathrm{N} / \mathrm{m}-\mathrm{mm}^{2}$ | 1/K | $\mathrm{kN} / \mathrm{mm}^{2}$ |
| 1.4 | 14/7 | 0.0491 | $15.10^{-6}$ | 110 |
|  | 14/19 |  |  |  |
| 1.7 | 12/7 | 0.0466 | 15,3.10 ${ }^{6}$ | 107 |
| 4.3 | 30/7 | 0.0375 | 17.8.10 ${ }^{6}$ | 82 |
| 6 | 6/1 | 0.035 | $\begin{aligned} & 19,2.10^{6} \\ & 18,9.10^{6} \end{aligned}$ | 81 |
|  | 26/7 |  |  | 77 |
| 7.7 | 24/7 | 0.0336 | $\begin{aligned} & 19,6 \cdot 10^{6} \\ & 19.3 .10^{6} \\ & 19,4 \cdot 10^{6} \end{aligned}$ | 74 |
|  | 54/7 |  |  | 70 |
|  | 54/19 |  |  | 68 |
| 11.3 | 48/7 | 0.032 | 20.5.10 ${ }^{6}$ | 62 |
| 14.5 | 45/7 | 0.0309 | 20,9.10 ${ }^{6}$ | 61 |
| 23.1 | 72/7 | 0.0298 | 21,7.10 ${ }^{6}$ | 60 |

The mass per unit and cross-sectional area is the load per $m$ conductor length and per $\mathrm{mm}^{\text {r }}$ conductor cross section, on which the calculation of the conductor sag is to be based.

## DIN 48203 PART 11

Table 2. Stranding constants

| Number of wires |  | Stranding constants for calculating |  |  |
| :---: | :---: | :---: | :---: | :---: |
| Aluminium | Steel | Aluminium | Steel | Electrical <br> resistance |
| 6 | 1 | 6.091 | 1 | 0.1692 |
| 12 | 7 | 12.26 | 7.032 | 0.08514 |
| 14 | 7 | 14.32 | 7.032 | 0.07306 |
| 14 | 19 | 14.32 | 19.15 | 0.07306 |
| 24 | 7 | 24.5 | 7.032 | 0.04253 |
| 26 | 7 | 26.56 | 7.032 | 0.03928 |
| 30 | 7 | 30.67 | 7.032 | 0.03408 |
| 45 | 7 | 45.98 | 7.032 | 0.02271 |
| 48 | 7 | 49.06 | 7.032 | 0.02129 |
| 54 | 7 | 55.23 | 7.032 | 0.01894 |
| 54 | 19 | 55.23 | 19.15 | 0.01894 |
| 72 | 7 | 73.68 | 7.032 | 0.01421 |


| Material | Wires | Stranded Conductors | Technical delivery conditions |  | IEC |
| :---: | :---: | :---: | :---: | :---: | :---: |
|  |  |  | New | Previous |  |
| Copper | DIN 48200 Part 1 | DIN 408201 Part 1 | DIN 48203 Part 1 | DIN 48202 Part 2 | . |
| Wrought Copper Alloys (Bz) | DIN 48200 Part 2 | DIN 408201 Part 2 | DIN 48203 Part 2 | DIN 48202 Part 2 | . |
| Steel | DIN 48200 Part 3 | DIN 408201 Part 3 | DIN 48203 Part 3 | DIN 48202 Part 1 | - |
| Aluminium | DIN 48200 Part 5 | DIN 408201 Part 5 | DIN 48203 Part 5 | DIN 48202 Part 1 | 207 |
| E-AlMgsi | DIN 48200 Part 6 | DIN 408201 Part 6 | DIN 48203 Part 6 | DIN 48202 Part 3 | 208 |
| Copper covered steel | DIN 8200 Part 7 | DIN 408201 Part 7 | DIN 48203 Part 7 | DIN 48202 Part 5 | . |
| Aluminium-clad steel | DIN 48200 Part 8 | DIN 408201 Part 8 | DIN 48203 Part 8 | DIN 48202 Part 1*) | . |
| Steel reinforced Aluminium |  | DIN 48204 | DIN 48203 Part 11 | DIN 48202 Part 1 | 209 |
| Steel reinforced E-AlMgsi |  | DIN 48206 | DIN 48203 Part 12 | DIN 48202 Part 4 | 210 |
| ${ }^{\text {*) }}$ January 1975 draft |  |  |  |  |  |

## USA - ASTM STANDARD B 399

Aluminium Alloy 6201 T-81 Condcutors
(Same diameter as ACSR Conductors)

| Code name | Conductor | Number of <br> wires | Wire <br> dia. | Cable <br> dia. | ACSR Conductor of <br> same dia. AWG or <br> KCmil and Stranding | Weight <br> per <br> 1000 ft | Breaking <br> load | Resistance <br> at20 ${ }^{\circ} \mathrm{C}$ |
| :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: |
|  | KCmil |  | (in) | (in) |  | Ibs | lbs | $\Omega / \mathrm{miles}$ |
| Akron | 35.58 | 7 | 0.0661 | 0.198 | 0.02402 | $6-6 / 1$ | 28.2 | 3.479 |
| Alton | 48.69 | 7 | 0.0834 | 0.250 | 0.03824 | $4-6 / 1$ | 45.7 | 2.185 |
| Ames | 77.47 | 7 | 0.1052 | 0.316 | 0.06084 | $2-6 / 1$ | 72.7 | 1.373 |
| Azusa | 123.3 | 7 | 0.1327 | 0.398 | 0.09681 | $1 / 0-6 / 1$ | 115.7 | 0.8631 |
| Anaheim | 155.4 | 7 | 0.149 | 0.447 | 0.1221 | $2 / 0-6 / 1$ | 145.9 | 0.6846 |
| Amherst | 195.7 | 7 | 0.1672 | 0.502 | 0.1537 | $3 / 0-6 / 1$ | 183.7 | 0.5437 |
| Alliance | 246.9 | 7 | 0.1878 | 0.563 | 0.1939 | $4 / 0-6 / 1$ | 231.8 | 0.4309 |
| Butte | 312.8 | 19 | 0.1283 | 0.642 | 0.2456 | $266-26 / 7$ | 293.6 | 0.3402 |
| Canton | 394.5 | 19 | 0.1441 | 0.721 | 0.3098 | $336-26 / 7$ | 370.3 | 0.2697 |
| Cairo | 465.4 | 19 | 0.1565 | 0.783 | 0.3655 | $397-26 / 7$ | 436.9 | 0.2286 |
| Darien | 559.5 | 19 | 0.1716 | 0.858 | 0.4394 | $477-26 / 7$ | 525.2 | 0.1902 |
| Elgin | 652.4 | 19 | 0.1853 | 0.927 | 0.5124 | $556-26 / 7$ | 612.4 | 0.1631 |
| Elint | 740.8 | 37 | 0.1415 | 0.991 | 0.5818 | $636-26 / 7$ | 695.4 | 0.1436 |
| Greeley | 927.2 | 37 | 0.1583 | 1.108 | 0.7282 | $795-26 / 7$ | 870.4 | 0.1148 |

USA - ASTM STANDARD B 399 M (metric)
Aluminium Alloy 6201 T-81 Conductors

| Conductor section | Number of wires | Wire dia. | Breaking load |
| :---: | :---: | :---: | :---: |
| $\mathrm{mm}^{2}$ |  | mm | kN |
| 630 | 37 | 4.66 | 181 |
| 560 | 37 | 4.39 | 161 |
| 500 | 37 | 4.15 | 143 |
| 450 | 37 | 3.94 | 129 |
| 400 | 37 | 3.71 | 115 |
| 355 | 37 | 3.5 | 102 |
| 315 | 37 | 3.29 | 90.2 |
| 280 | 19 | 3.1 | 83.9 |
| 250 | 19 | 4.09 | 73.1 |
| 224 | 19 | 3.87 | 65.5 |
| 200 | 19 | 3.66 | 58.6 |
| 180 | 19 | 3.47 | 52.6 |
| 160 | 19 | 3.27 | 46.7 |
| 140 | 19 | 3.06 | 42.9 |
| 125 | 19 | 2.89 | 38.3 |
| 112 | 7 | 4.51 | 33.8 |
| 100 | 7 | 4.26 | 30.2 |
| 80 | 7 | 3.81 | 24.1 |
| 63 | 7 | 3.39 | 19.1 |
| 50 | 7 | 3.02 | 15.9 |
| 40 | 7 | 2.7 | 12.7 |
| 31.5 | 7 | 2.39 | 9.95 |
| 25 | 7 | 2.13 | 7.9 |
| 20 | 7 | 1.91 | 6.35 |
| 16 | 7 | 1.71 | 5.09 |

BS: 3242

## 2. MATERIAL

The conductor shall be constructed of heat treated Aluminium - Magnesium Silicon Alloy wires having the mechanical and electrical properties specified in this British Standard.

NOTE. A suitable material is one containing amounts of Magnesium and Silicon appropriates to the mechanical and electrical properties specified and containing not more than $0.05 \%$ coppers.
By agreement between the purchaser and the manufacturer suitable grease may be applied to the center wire, or additionally to wires in specific layers, evenly throughout the length of the conductor.

## 3. DIMENSIONS AND CONSTRUCTION

### 3.1 STANDARD SIZES OF WIRES

After drawing and heat treatment, the Aluminium Alloy wires for the standard constructions covered by this specifications shall have the diameters specified in Table 2.

### 3.2 TOLERANCES ON THE STANDARD DIAMETERS OF WIRES

A tolerance of $\pm 1 \%$ is permitted on the standard diameters of all wires. The cross section of any wire shall not depart from circularity by more than an amount corresponding to a tolerance of $1 \%$ on the standard diameter:
3.3 STANDARD SIZES OF ALUMINIUM ALLOY STRANDED CONDUCTORS

The sizes of standard Aluminium Alloy stranded conductors are given in Table 3. The masses (excluding the mass of grease for corrosion protection and resistances may be taken as being in accordance with Table 3.
3.4 JOINTS IN WIRES
3.4.1 Conductors containing more than seven wires: There shall be no joints in any wire of a stranded conductor containing seven wires, except those made in the base rod or wire before final drawing.
3.4.2 Conductors containing more than seven wires: in stranded conductors containing more than seven wires, in addition to joints made in the base rod before final drawing, joints in individual wires made by cold-pressure bull-welding are permitted in any layer and those made by resistance bull-welding are permitted in any layer except the outermost layer. No two such joints shall be less than 15 m apart in the complete stranded conductors. They are not required to fulfill the mechanical or electrical requirements for unjointed wire. Joints made by resistance bull-welding shall, subsequent to welding, be annealed over a distance of a least 200 mm on each side of the joint.
3.5 STRANDING
3.5.1 The wire used in the construction of a stranded conductor shall, before stranding, satisfy all the relevant requirements of this standard.
3.5.2 The lay ratio of the different layers shall be within the limits given in Table. 1

NOTE: It is important to note that lay ratio is now defined as the ratio of the axial length of a complete turn of the he lix formed by an individual wire in a stranded conductor to the external diameter of the helix.
3.5.3 In all constructions, the successive layers shall have opposite directions of lay, the outermost layer being right handed. The wires in each layer shall be evenly and closely stranded.
3.5.4 In Aluminium Alloy stranded Conductors having multiple layers of wires, the lay ratio of any layer shall be not greater than the lay ratio of the layer immediately beneath it.

## TABLE 1: LAY RATIOS FOR ALUMINIUM ALLOY STRANDED CONDUCTORS

| Number of wires in <br> conductor | Lay Ratio |  |  |  |  |  |
| :---: | :---: | :---: | :---: | :---: | :---: | :---: |
|  | 6 -wire layer |  | 12-wire layer |  | 18-wire layer |  |
|  | Min. | Max. | Min. | Max. | Min. | Max. |
| 7 | 10 | 14 | - | $\cdots$ | $\cdots$ | - |
| 19 | 10 | 16 | 10 | 14 | $\cdots$ | - |
| 37 | 10 | 17 | 10 | 16 | 16 | 14 |

### 3.6 COMPLETED CONDUCTOR

The completed conductor shall be free from dirt, grit, and excessive amounts of awing oil and other foreign deposits.

## 4. TESTS

### 4.1 SELECTION OFTEST SAMPLES

4.1.1 Samples for the tests specified in 4.3 and 4.4 shall be taken by the manufacturer before stranding, from not less than $10 \%$ of the individual lengths of Aluminium Alloy wire included in any one final heat treatment batch. One sample, sufficient to provide one test specimen foreach test, shall be taken from each of the selected lengths of wire.
4.1.2 Alternatively, when the purchaser states at the time of ordering that he desire tests to be made in the presence of his representative, samples of wire shall be taken from lengths of stranded conductor selected from approximately $10 \%$ of the lengths included in any one consignment. One sample, sufficient to provide one specimen for each of the appropriate tests, shall be taken from each of an agreed number of wires of the conductor in each of the selected lengths.

### 4.2 PLACEOFTESTING

Unless otherwise agreed between the purchaser and the manufacturer at the time of ordering, all tests shall be made at the manufacturer's works.

### 4.3 MECHANICALTESTS

4.3.1 Tensile test. The test shall be made in accordance with BS $18^{*}$. on a specimen cut from each of the samples taken as specified on 4.1.1 or 4.1.2. The load shall be applied gradually and the rate of separation of the jaws of the testing machine shall be not less than $25 \mathrm{~mm} / \mathrm{min}$ and not greater than $100 \mathrm{~mm} / \mathrm{min}$.
When tested before or after stranding, the tensile strength of the specimen shall be not less than 29.5 hbart.
4.3.2 Elongation test. The test shall be made in accordance with $\mathrm{BS} 18^{*}$. The load shall be applied gradually and uniformly on a specimen cut from each of the samplestaken as specified in 4.1 .1 or 4.1 .2 having an original gauge length of 250 mm .
The elongation shall be measures on the gauge length after the fractured ends have been fitted together. The determination shall be valid, whatever the position of the fracture, if the specified values in reached. If the specified value is not reached, the determination shall be valid only if the fracture occurs between the gauge marks and not closer than 25 mm toeither mark.
When tested before of after stranding, the elongation shall be not less than $3.5 \%$.

### 4.4 ELECTRICALRESISTIVITYTEST

The resistivity of one specimen cut from each of the samples taken as specified in 4.1.1 or 4.1.2 shall be determined in accordance with the routine method give in $\mathrm{Bs} 3239+$.
The resistivity at $20^{\circ} \mathrm{C}$ shall not exceed $3.28 \mathrm{mw} / \mathrm{cm}$.

### 4.5 CERTIFICATE OF COMPLIANCE

When the purchaser does not call for tests on wires taken from the stranded conductor the manufacturer shall, if requested, furnish him with a certificate giving the results of the tests made on the samples taken in accordance with 4.1.1.

## TABLE 2: ALUMINIUM ALLOY WIRES USED IN THE CONSTRUCTION OF STANDARD ALUMINIUM ALLOY STRANDED CONDUCTORS

| Standard <br> diameter | Cross - <br> sectional area <br> of standard <br> diameter Wire | Mass per | Standard <br> resistance at <br> $20^{\circ} \mathrm{C}$ per km | Minimum <br> breaking load <br> for standard <br> diameter wire | Standard <br> diameter |
| :---: | :---: | :---: | :---: | :---: | :---: |
| $\mathbf{m m}$ | $\mathrm{mm}^{\mathbf{2}}$ | km kg | x | N | mm |
| 2.34 | 4.301 | 11.61 | 7.557 | 1270 | 2.34 |
| 2.54 | 5.067 | 13.68 | 6.414 | 1490 | 2.54 |
| 2.95 | 6.835 | 18.45 | 4.755 | 2020 | 2.95 |
| 3.30 | 8.553 | 23.09 | 3.800 | 2520 | 3.30 |
| 3.48 | 9.511 | 25.68 | 3.417 | 2810 | 3.48 |
| 3.53 | 9.787 | 26.42 | 3.321 | 2890 | 3.53 |
| 3.76 | 11.10 | 29.98 | 2.927 | 3280 | 3.76 |
| 4.65 | 16.98 | 45.85 | 1.914 | 5010 | 4.65 |

[^2]TABLE 3: STANDARD ALUMINIUM ALLOY STRANDED CONDUCTORS

| 1 | 2 | 3 | 4 | 5 | 6 | 7 | 1 |
| :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: |
| Nominal Aluminium area | Stranding and wire diameter | Sectional area | Approximately overall diameter | Approximately mass per km | Calculated D.C. resistance at $20^{\circ} \mathrm{C}$ $\Omega / \mathrm{km}$ | Calculated breaking load | Nominal Aluminium area |
| $\mathrm{mm}^{2}$ | mm | $\mathrm{mm}^{2}$ | mm. | kg | $\Omega$ | kN | $\mathrm{mm}^{2}$ |
| 25 | 7/2.34 | 30.10 | 7.02 | 82 | 1.094 | 8.44 | 25 |
| 30 | 7/2.54 | 35.47 | 7.62 | 97 | 0.9281 | 9.94 | 30 |
| 40 | 7/2.95 | 47.384 | 8.85 | 131 | 0.6830 | 13.40 | 40 |
| 50 | 7/3.30 | 59.87 | 9.90 | 164 | 0.5498 | 16.80 | 50 |
| 100 | 7/4.65 | 118.9 | 13.95 | 325 | 0.2769 | 33.30 | 100 |
| 150 | 19/3.48 | 180.7 | 17.40 | 497 | 0.1830 | 50.64 | 150 |
| 175 | 19/3.76 | 211.0 | 18.80 | 580 | 0.1568 | 59,10 | 175 |
| 300 | 37/3.53 | 362.1 | 24.71 | 997 | 0.09155 | 101.5 | 300 |

## Note:

1. For the basic of calculation of this table, see Appendix A.
2. The sectional area of an Aluminium Alloy Stranded Conductor is the sum of the cross sectional area of the individual wires.
3. Attention is drawn tothe fact that the sectional areas of standard conductors covered by the specification refer to Aluminium Alloy areas. consequently they are larger than the nominal aluminium areas by which they are identified.

## APPENDIXA

## NOTES ON THE CALCULATION OF TABLE 3

A-1 Increase in length due to stranding. When straightened out, each wire in any particular layer of a stranded conductor, except the central wire, is longer than the stranded conductor by an amount depending on the lay ratio of that layer.
A-2 Resistance and mass of conductor. The resistance of any length of a stranded conductor is the resistance of the same length of any one wire multiplied by a constant as set out in Table 4.
The mass of each wire in any particular layer of stranded conductor except the central wire, will be greater than that of an equal length of straight wire by an amount depending on the lay ratio of that layer (see A-1 above). The total mass of any length of an Aluminium Alloy Stranded Conductor is, therefore obtained by multiplying the mass of an equal length of straight wire by an appropriate constant, as set out in Table 4.
In calculating the stranding constants in Table 4, the mean lay ratio i.e. the arithmetic mean of the relevant minimum and maximum values in Table 1, has been assumed for each layer.
A-3 Calculated breaking load of conductor. The breaking load of an Aluminium Alloy Stranded Conductor in terms of the strengths of the individual component wires, may be taken to be $95 \%$ of the sum of the strengths of the individual Aluminium Alloy wires calculated from the value of the minimum tensile strength given in 4.3.1.

## TABLE 4: STRANDING CONSTANTS

| Numbers of wire in conductor | Stranding constants Mass | Electrical resistance |
| :---: | :---: | :---: |
| 7 | 7.091 | 0.1447 |
| 19 | 19.34 | 0.05357 |
| 37 | 37.34 | 0.02757 |

## APPENDIX B

## NOTE ON MODULUS OF ELASTICITY AND COEFFICIENT OF LINEAR EXPANSION

The practical module of elasticity given below are based on an analysis the final module determined from a large number short-term stress/strain tests and may be taken as applying to conductors stressed between $15 \%$ and $50 \%$ of the breaking load of the conductor. They may be regarded as being accurate to within $\pm 300 \mathrm{hbar}$ *.

| Number of wires in <br> conductor | Practical (final) modulus of <br> elasticity $\left(\mathrm{hbar}^{2}\right)$ | Coefficient of linear <br> expansion $/{ }^{\circ} \mathrm{C}$ |
| :---: | :---: | :---: |
| 7 | 5900 | $23.0 \times 10^{-6}$ |
| 19 | 5600 | $23.0 \times 10^{-6}$ |
| 37 | 5600 | $23.0 \times 10^{-6}$ |

Note: These values are given for information purposes only.

## APPENDIX C

CODE NAMES FOR STANDARD ALUMINIUM ALLOY STRANDED CONDUCTORS
Note: These code names are not an essential part of the standard. They are given for convenience in ordering conductors.

| Nominal Aluminum area $\mathrm{mm}^{2}$ | Stranding mm. | Code name |
| :---: | :---: | :---: |
| 25 | $7 / 2.34$ | ALMOND |
| 30 | $7 / 2.54$ | CEDAR |
| 40 | $7 / 2.95$ | FIR |
| 50 | $7 / 3.30$ | HAZEL |
| 100 | $7 / 4.65$ | OAK |
| 150 | $19 / 3.48$ | ASH |
| 175 | $19 / 3.76$ | ELM |
| 300 | $37 / 3.53$ | UPAS |

APPENDIX D
LAY RATIOS AND STRANDING CONSTANTS FOR NON STANDARD CONSTRUCTION

| Number of wires in conductor | Lay ratio |  |  |  |  |  |  |  |  |  | Stranding constants |  |
| :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: |
|  | 6-wire layer |  | 12-wire layer |  | 18-wire layer |  | 24-wire layer |  | 30-wire layer |  | Mass | Electrical resistance |
|  | min | max | min | max | min | max | min | max | min | max |  |  |
| 61 | 10 | 17 | 10 | 16 | 10 | 15 | 10 | 14 | - | - | 62.35 | 0.01676 |
| 91 | 10 | 17 | 10 | 16 | 10 | 15 | 10 | 14 | 10 | 13 | 93.26 | 0.01126 |

BS 215 (P II) / 1970

## 1. GENERAL

### 1.1 SCOPE

Part 2 of this British Standard applies to aluminium conductors, steel-reinforced for overhead power transmission.
1.2 DEFINITIONS

For the purpose of this part of this British Standard the following definitions apply.
Aluminium conductors, steel-reinforced. A conductor consisting of seven or more Aluminium and galvanized steel wires built up in concentric layers. The center wire or wires are of galvanized steel and the outer layer of layers of aluminium.
Diameter. The mean of two measurements at right angles taken at the same cross section.
Direction of lay. The direction of lay is defined as right-hand or left-hand. With right-hand lay, the wires conform to the direction of the central part of the letter S when the conductor is held vertically.
Lay ratio. The ratio of the axial length of a complete turn of the helix formed by an individual wire in a stranded conductor to the external diameter of the helix.
For other definition reterence should de made to US 205.
1.3 STANDARD FOR HARD-DRAWN ALUMINIUM WIRES
1.3.1 Resistivity. The resistivity of Aluminium wire depends upon its purity and its physical condition. For the purpose of this British Standard, the maximum value permitted is 2.8264 mw , at $20^{\circ} \mathrm{C}$, and this value shall also be used as the standard resistivity for the purpose of calculation.
1.3.2 Density. At a temperature of $20^{\circ} \mathrm{C}$ the density of hard drawn aluminium wire is to be taken as $2.703 \mathrm{gms} / \mathrm{cm}^{3}$.
1.3.3 Coefficient of linear expansion. The coefficient of linear expansion of hard drawn Aluminium is to be taken as $23 \times 10.6 /{ }^{\circ} \mathrm{C}$.
1.3.4 Constant mass temperature coefficient. At a temperature of $20^{\circ} \mathrm{C}$ the constant mass temperature coefficient of resistance of hard drawn Aluminium wire, measured between two potential points rigidly fixed to the wire, is taken as $0.00403 /{ }^{\circ} \mathrm{C}$.

### 1.4 STANDARD FORGALVANIZED STEEL WIRE

1.4.1 Density. At a temperature of $20^{\circ} \mathrm{C}$ the density of galvanized steel wire is to be taken as $7.80 \mathrm{~g} / \mathrm{cm}^{3}$.
1.4.2 Coefficient of linear expansion. In order to obtain uniformity in calculations, a value of $11.5 \times 10-4 /{ }^{\circ} \mathrm{C}$ be taken as the value for the coefficient of linear expansion of galvanized steel wires used for the aluminium conductors, steel reinforced.
2. MATERIAL

The aluminium wires used in the construction of the conductor shall be material GIE in the H 9 condition as specified in BS 2627.

The galvanized steel wires shall be of the standard tensile strength grads given in BS 4565 unless due of the higher tensile strength grades is specified by the purchaser.
By agreement between the purchaser and the manufacturer a suitable grease may be applied to the center wire, or additionally to wires in specific layers, evenly throughout the length of the conductor.

## 3. DIMENSIONS AND CONSTRUCTIONS

### 3.1 STANDARD SIZE OFWIRES

The Aluminium and Steel wires for the standard constructions covered by this specification shall have the diameters specified in Table 2 and 3 respectively. The diameters of the stee I wires shall be measured over the zinc coating.
3.2 STANDARD SIZES OF ALUMINIUM CONDUCTORS, STEEL REINFORCED.
3.2.1 The sizes of standard Aluminium Conductors, Steel reinforced are given in table 4.
3.2.2 The masses (excluding the mass of grease for corrosion protection) and resistance's may be taken as being in accordance with Table 4.
3.3 JOINTS INWIRES
3.3.1 Aluminium wires. In aluminium conductors, steel reinforced, containing any number of Aluminium wires, joints in individual Aluminium wires are permitted, in addition to those made in the base rod or wire before final drawing, but no two such joints shall be less than 15 m apart in the complete stranded conductor. Such joints shall be made by resistance or cold pressure bull welding. They are not required to fulfill the mechanical requirements for unjointed wires. Joints made by resistance bull welding shall, subsequent to welding, be annealed over a distance of at least 200 mm , on each side of the joint.
3.3.2 Galvanized steel wires. There shall be no joints, except those made in the base rood or wire before final drawing, in steel wires forming the core of an Aluminium Conductor, Steel reinforced, unless the core consists of seven or more galvanized steel wires. In the latter case joints in individual wires are permitted, in addition to those made in the base rod or wire before final drawing, but no two such joints shall be less than 15 m apart in the complete steel core. Joints in galvanized steel wires shall be made by resistance bull welding and shall be protected against corrosion.
3.4 STRANDING
3.4.1 The wires used in the construction of an Aluminium Conductor, Steel reinforced shall, before stranding, satisfy all the relevant requirements of this standard.
3.4.2 The lay ratio of the different layers shall be within the limits given in Table 1.

Notes: It is important to note that lay ratio is now defined as the ratio of the exist length of a complete turn of the helix formed by an individual wire in stranded conductor to the external diameter of the helix.
3.4.3 In all constructions, the successive layers shall have opposite directions of lay, the outermost layer being right handed. The wires in each layer shall be evenly and closely stranded.
3.4.4 In conductors having multiple layers of Aluminium wires, the lay ratio of nay Aluminium layer shall be not greater than the lay ratio of the Aluminium layer immediately beneath it.
3.4.5 Steel wire shall be formed during stranding so that they remain inert when the conductor is cut.

TABLE 1: LAY RATIOS FOR ALUMINIUM CONDUCTORS, STEEL - REINFORCED

| Numbers of wires |  | Ratio of Aluminium to Steel wire diameter | Lay ratios for steel core |  | Lay ratios for Aluminium layers |  |  |  |  |  |  |  |
| :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: |
|  |  | 6 -layer wire |  |  | 12-layer wire |  | 18-layer wire |  | 24-layer wire |  |
| Alu. | Steel |  | min | max | min | max | min | max | min | max | min | max |
| 6 | 1 |  | 1.000 | * | -- | 10 | 14 | $\cdots$ | - | - | - | . | * |
| 6 | 7 | 3.000 | 13 | 28 | 10 | 14 | $\cdots$ | - | - | - | . | - |
| 12 | 7 | 1.000 | 13 | 28 | - | - | 10 | 14 | - | - | - | - |
| 18 | 1 | 1.000 | .. | - | 10 | 16 | 10 | 14 | -* | * | * | * |
| 30 | 7 | 1.000 | 13 | 28 | * | * | 10 | 16 | 10 | 14 | * | * |
| 54 | 7 | 1.000 | 13 | 28 | .. | . | 10 | 17 | 10 | 16 | 10 | 14 |

### 3.5 COMPLETED CONDUCTOR

The completed conductor shall be from dirt, and excessive amounts of drawing oil and other foreign deposits.
4. TESTS

### 4.1 SELECTION OF TEST SAMPLES

4.1.1 Samples for the tests specified in 4.3 shall be taken by the manufacture before standing, from not less than $10 \%$ of the individual lengths of Aluminium and galvanized Steel wire which will be included in any one consignment of stranded conductor.
One sample, sufficient to provide one test specimen for each of the appropriate test, shall be taken from each of the selected conductor.
4.1.2 Alternatively, when the purchaser states at the time of ordering that he desires tests to be made in the presence his representative, samples of wire shall be taken from lengths of stranded conductor selected from approximately $10 \%$ of the lengths included in any one consignment.
One sample, sufficient to provide one specimen for each of the appropriate tests, shall be taken from each of an agreed number of wires of the conductor in each of the selected lengths.

### 4.2 PLACE OF TESTING

Unless otherwise agreed between the purchase and the manufacturer at the time of ordering, all tests shall be made at the manufacturer's works.

### 4.3 TESTS

4.3.1 Aluminum wires. The test samples of Aluminum wires taken under 4.1.1 shall be subject to the following tests in accordance with BS 2627* and shall meet the requirements of that standard:

Tensile test
Wrapping test.
Resistively test
Test samples of Aluminum wires taken under 4.1 .2 shall be subjects to the same tests but in the case of the tensile test the tensile strength of the specimen shall not be less than 95\% of the appropriate minimum value specified in BS 2627*.
4.3.2 Steel wires. The test samples of galvanized steel wires taken under 4.1 .1 shall be subjected to the following tests in accordance with BS 4565 t and shall meet the requirements of that standard.

Determination of stress at $1 \%$ elongation.
Tensile test
Torsion test or elongation test as appropriate.
Wrapping test.
Galvanizing test.
The test sample of galvanized steel wires taken under 4.1.2 shall be subjected to the following tests in accordance with BS 4565 t .

Determination of Stress at $1 \%$ elongation.
Tensile test
Torsion test or elongation test as appropriate.
Wrapping test.
Galvanizing test.
In the case of the tensile test the tensile strength of the specimen shall not be less than $95 \%$ of the appropriate minimum value specified to BS 4565*.
In the case of the elongation test the elongation of the specimen shall be not less than the appropriate minimum value specified in $\mathrm{BS} 4565^{*}$ reduced in numerical value by 0.5 .
In the case of the stress at $1 \%$ elongation, torsion, wrapping and galvanizing tests the appropriate requirements of BS 4565* shall be met.
NOTE: Because of the difficulty in straightening samples taken from stranded cores, it is recommended that determination of stress at $1 \%$ elongation on samples taken under 4.1.2 be carried out on the center wire only.

### 4.4 CERTIFICATION OF COMPLIANCE

When the purchaser does not call for tests on wire taken from the stranded conductor the manufacturer shall, if requested, furnish him with a certificate given the results of the tests made on the samples taken in accordance with

TABLE 2: ALUMINIUM WIRES USED IN THE CONSTRUCTION OF STANDARD ALUMINIUM CONDUCTORS, STEEL REINFORCED

| Standard <br> Diameter | Cross sectional <br> Area of stranded <br> diameter wire | Mass Per kms | Standard <br> Resistance at <br> $20^{\circ} \mathrm{C} \Omega / \mathrm{km}$ | Min. breaking <br> load for <br> standard <br> diameter wire | Standard <br> Diameter |
| ---: | ---: | ---: | ---: | ---: | ---: |
| $m m$ | $\mathrm{~mm}^{2}$ | kg | $n$ | N | mm |
| 2.36 | 4.374 | 11.82 | 6.461 | 770 | 2.36 |
| 2.59 | 5.269 | 6.114 | 14.24 | 5.365 | 9.623 |

TABLE 3: STEEL WIRES USED IN THE CONSTRUCTION OF STANDARD ALUMINIUM CONDUCTORS, CONDUCTORS, STEEL REINFORCED

| Standard diameter | Cross-sectional <br> area of stranded <br> diameter wire | Mass per km | Minimum load at <br> \% elongation for <br> standard diameter <br> wire | Standard diameter |
| ---: | ---: | ---: | ---: | ---: |
| $m m$ | ${m m^{2}}^{m m}$ | kg | N | mm |
| 1.57 | 1.936 | 15.10 | 2.280 | 1.57 |
| 2.36 | 4.374 | 34.12 | 4.990 | 2.36 |
| 2.59 | 5.269 | 41.09 | 6.010 | 2.59 |
| 2.79 | 6.114 | 47.69 | 6.970 | 2.79 |
| 3.00 | 7.069 | 55.13 | .069 | 3.00 |
| 3.18 | 7.942 | 61.95 | 8.740 | 3.18 |
| 3.06 | 8.814 | 68.75 | 9.700 | 3.35 |
| 3.61 | 10.24 | 79.86 | 11.260 | 3.61 |
| 3.86 | 11.70 | 91.28 | 12.870 | 3.86 |

Note: The Values in Columns 2 to 4 are given for information only.

## TABLE 4. STANDARD ALUMINIUM CONDUCTORS, STEEL REINFORCED

| Normal Aluminium area | Stranding and wire diameter |  | Sectional area of Aluminium | Total sectional area | Approximate overall diameter | $\begin{gathered} \text { Approximate } \\ \text { mass } \\ \text { per } \mathrm{km} \end{gathered}$ | Calculated D.C. <br> resistance at $20^{\circ} \mathrm{C} \Omega / \mathrm{km}$ | Calculated breaking load | Normal Aluminium area |
| :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: |
|  | Aluminum | Steel |  |  |  |  |  |  |  |
| $\mathrm{mm}^{2}$ | mm | mm | $\mathrm{mm}^{2}$ | $\mathrm{mm}^{2}$ | mm | kg | $\Omega$ | kN | $\mathrm{mm}^{2}$ |
| 25 | 6/2.36 | 1/2.36 | 26.34 | 30.62 | 7.06 | 106 | 1-093 | 9.61 | 25 |
| 30 | $6 / 2.59$ | 1/2.59 | 31.51 | 36.88 | 7.77 | 128 | 0.907 7 | 11.45 | 30 |
| 40 | 3/3.00 | 1/3.00 | 42.41 | 49.48 | 9.00 | 172 | 0-6766 | 15.20 | 40 |
| 50 | 6/3.35 | 1/3.35 | 52.58 | 61.70 | 10.05 | 214 | 0-5436 | 18.35 | 50 |
| 70 | 12.278 | 7/2.70 | 73.37 | 116.2 | 13.98 | 538 | 0-583 8 | 61.30 | 7 |
| 100 |  | 7/2/72 | 73.37 | 116.2 | 15.56 | 558 | 0.2733 | 32.70 | 100 |
| 150 | 30/2.59 | 7/2.59 | 1581 | 194.9 | 18.13 | 726 | 0-1838 | 69.20 | 150 |
| 150 | 18/3.35 | 1/3.35 | 158.7 | 157.5 | 16.75 | 506 | 0-1815 | 35.70 | 150 |
| 175 | 30/2.79 | 7/2.79 | 183-4 | 225.2 | 19.63 | 842 | 0-157 6 | 79.80 | 175 |
| 175 | 18/3.61 | 1/3.61 | 184.3 | 194.5 | 18.05 | 587 | 0-1563 | 41.10 | 175 |
| 200 | 30/3.00 | 7/3.00 | 212.1 | 261.5 | 21.00 | 974 | 0-1363 | 92.25 | 200 |
| 200 | 18/3.86 | 1/3.86 | 210.6 | 222.3 | 19.30 | 671 | 0.136 7 | 46.55 | 200 |
| 400 | 54/3.18 | 7/3.18 | 428.6 | 484.5 | 28.52 | 1.621 | 0-067 40 | 131.9 | 400 |

## Notes on Table 4:

1. For the basis of calculation of this table, see Appendix A.
2. The sectional area is the of the sectional area of the relevant individual wires.
3. Attention is drawn to the fact that the Aluminium sectional areas of standard conductors covered by this specification are larger than the nominal Aluminium areas by which they are identified, they should not be compared directly with conductors manufacture exactly to nominal areas.

## APPENDIXA

## NOTES ON THE CALCULATION OF TABLE 4

A. 1 Increase in length due to standing. When straightened out, each wire in any particular layer of a stranded conductor, except the central wire, is longer than the standard conductor, by an amount depending on the lay ratio of that layer.
A. 2 Resistance and mass of conductor. In Aluminium conductors, steel-reinforced the conductivity of the steel core is neglected and the resistance of the conductor is calculated with reference to the resistance of the Aluminium wires only. The resistance of any length of stranded conductor is the resistance of the same length of any one Aluminium wire multiplied by a constant, as set out in Table 5 .
The mass of each wire in a length of stranded conductor, except the central wire, will be greater than that of an equal length of straight wire by an amount depending on the lay ratio of the layer (see A. 1 above). The total mass of any length of conductor is, therefore, obtained by multiplying the mass of an equal length of strength wire by their appropriate constant set out in Table 5 . The masses of the steel core and aluminum wires are calculated separately and added together
In calculating the stranding constants in Table 5, the mean by ratio, i.e. the arithmetic mean of the relevant minimum and maximum values in Table 1 , has been for each layer.
A. 3 Calculated breaking load of conductor. The breaking load of a conductor, in terms of the strengths of the individual component wires, may be taken to be the sum of the strengths of the Aluminium wires calculated from the specified minimum tensile strengths plus the sum of the strengths of the steel wires calculated from the specified minimum stress at $1 \%$ elongation.

TABLE 5. STRANDING CONSTANTS

| Number of wires in conductor | Stranding constants |  |  |  |
| ---: | ---: | ---: | ---: | ---: |
|  | Mass |  | Electrical resistance |  |
| Aluminium |  | Steel |  | Steel |
| 6 | 1 | 6.091 | 1.000 | 1.1692 |
| 6 | 7 | 6.079 | 7.032 | 0.1692 |
| 12 | 7 | 12.26 | 7.032 | 0.08514 |
| 18 | 1 | 18.34 | 1.000 | 0.05660 |
| 30 | 7 | 30.67 | 7.032 | 0.03408 |
| 54 | 7 | 55.21 | 7.032 | 0.01804 |

## APPENDIX B

## NOTE ON MODULUS OF ELASTICITY AND COEFFICIENT OF LINEAR EXPANSION

The practical moduli of elasticity given below are based on an analysis of the final moduli determined from a large number of short term stress / strain tests and may be taken as applying to conductors stressed between $15 \%$ and $50 \%$ of the breaking load of the conductor. They may be regarded as being accurate to with in $+300 \mathrm{hbar*}$.
The coefficient of linear expansion given below have been calculated from the practical moduli for the aluminum and steel components of the conductors and coefficient of linearexpansion of $23.0 \times 10-2$ and $11.5 \times 10-4 /$. . Aluminium and Steel respectively.

| Number of wires in conductor |  | Practical (final) modular of <br> elasticity | Coefficient of linear <br> expansion $/{ }^{\circ} \mathrm{C}$ |
| ---: | ---: | ---: | ---: |
| Aluminium | Steel | 7.900 | $19.1 \times 10^{-6}$ |
| 6 | 1 | 7.500 | $19.8 \times 10^{-4}$ |
| 6 | 7 | 10.500 | $15.3 \times 10^{-6}$ |
| 12 | 7 | 6.600 | $21.2 \times 10^{-4}$ |
| 18 | 1 | 8.000 | $17.8 \times 10^{-4}$ |
| 30 | 7 | 6.900 | $19.3 \times 10^{4}$ |
| 54 | 7 |  |  |

Note: These values are given for information purposes only

## APPENDIX C

CODENAMES FOR STANDARD ALUMINIUM CONDUCTORS, STEEL-REINFORCED
NOTE: These code names are not an essential part of the standard. They are given for convenience in ordering conductors.

| Nominal Aluminium <br> Area | Stranding |  | Code Name |
| ---: | ---: | ---: | ---: |
|  | Aluminium |  |  |
| $\mathrm{mm}^{2}$ | mm | mm |  |
| 25 | $6 / 2.35$ | $1 / 2.36$ | Copier |
| 30 | $6 / 2.59$ | $1 / 2.59$ | Weasel |
| 40 | $6 / 3.00$ | $1 / 3.09$ |  |
| 50 | $6 / 3.35$ | $1 / 3.35$ | Rabolt |
| 70 | $12 / 2.79$ | $7 / 2.79$ | Horse |
| 100 | $6 / 4.72$ | $7 / 1.57$ | Dog |
| 150 | $30 / 2.59$ | $7 / 2.59$ | Wolf |
| 150 | $18 / 3.35$ | $1 / 3.35$ | Dingo |
| 175 | $30 / 2.79$ | $7 / 2.79$ | Lynx |
| 175 | $18 / 3.61$ | $1 / 3.61$ | Caracal |
| 200 | $30 / 3.00$ | $7 / 3.00$ | Panther |
| 20 | $18 / 3.89$ | $1 / 3.86$ | Jaguar |
| 400 | $54 / 3.10$ | $7 / 3.18$ | Zebra |

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[^0]:    Technical team

[^1]:    Note: Current Capacity at $\mathrm{a}=0.5, \mathrm{e}=0.5, \mathrm{~s}=985, \mathrm{v}=2200$
    Ambient Temperature $40^{\circ} \mathrm{C}$ at sea level

[^2]:    Note: The values given in Columns 2 to 5 are given for information only.

