HANDLING AND INSTALLATION

CABLE GUIDES

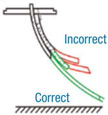
After considering the correct reeling system, the cable guides became the next step to be looked at properly.
Some misuse of the handling of these guides lead to some major reeling system problems. Amongst the various guide types the best are the radius types as they provide generous bending radii with minimum cable deflection. Our last mandatory recommendation is to keep the guide exactly aligned with the payout plane of the cable: every misalignment can lead to an increase of torsion on the cable itself.

One way or two ways guides

A one way guide often appears even on two directions payout as it seems the most economic solution. However a considerable increase in cable life is obtained if a two way guide is used: in fact the net torsional and "massaging" effects imparted by the guide to the cables are balanced using a symmetrical two way one. This problem doesn't occur if the reeling system is end fed. In this case the one-directional guide is in contact with the cable regardless of the direction of travel of the machine.

A part from this, the two-way guide or the multi roller systems, this is the preferred one. Multi roller or two-way guide should be designed to continue the arc beyond the angle of deflection. In this way the minimum bending radii is always maintained.

As a general note, you have to absolutely avoid any abrupt changes of the bending radius (often this is due to a not enough long angle of deflection of the roller guide arc). These changes lead to a punctual overpressure that results into a cable breakage.



Over and under tension protection

It is highly recommended that cable guiding systems include both under and over tension protection systems. Even a short exposure to over tension caused by mechanical failure or accidents can render a cable inoperable due to permanent conductor deformation or breakage. Conversely, under tension protection is desirable to ensure that cable cannot free spool from the reel and sustain damage. This protection is particularly important for high mounted cable reels. All over tension protection devices should be set to the maximum continuous safe working tension defined for each cable section.

BASKETHEAVYFLEX

Suggested cable coiling

Even if the Basketheavyflex cable has been especially designed for this type of application, the correct design of the basket is important not only as far as cable life is concerned, but also to avoid operating malfunction.
High stress applications will be typically involve long vertical lengths, high speed combined ascent and descent with movement and, often, the presence of strong winds. In these cases care must be taken to ensure that coiling diameter is not less than 1,5 m. A centrally guide cone centrally placed into the basket is recommended for even coiling the cable correctly. The shape of the basket and of the opening are also important operating factors: with high lift and high speed a height of at least 2 m and a conical opening are recommended.

Good cable coiling Less controlled coiling Poor coiling control

The cable has to be laid, from the bottom of the basket, in anticlockwise direction starting from the outer layer of the original cable drum.

Scope of the information given herewith is to assure the PALAZZO PRYSMIAN's deep commitment to giving the customer the best support for a perfect use of our products.
Life and performance of our PANZERFLEX, depend directly on all the recommendations and figures stated in this technical section.
Furthermore we would like to underline that the main topics that must be regularly and carefully checked are:

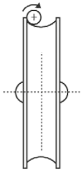
- the perfect alignment of all equipments such as: lyres, reels, sheaves, etc.
- all the protection devices in order to avoid over and under tensions.
- any twisting induced (and not released) during installation or test-run activities.

The misuse of even one the above instructions will surely lead to premature cable failures.

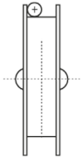
SHEAVES

Comparing them with the previously described guide types, some difficulties are clear. The sheaves' weight increases inertia, so more torque is needed to compensate it giving a final increase on cable tension so reducing its life. Another disadvantage to be considered from using a sheaved guide is the detrimental effect onto the cable outer sheath
that is directly in contact with the sheave circumference. This contact area should increase if a hollow internal sheave shape is used. This becomes a particularly significant condition that will lead to a considerable reducing of the cable life and this is why we suggest to use a correct sheave profile as shown in the below image.

Incorrect sheaved profile
Torsion is induced on the cable due to rolling effect leading to a reducing in cable life.



Correct sheaved profile
This design minimizes torsion applied on the cable.



CHANGE OF DIRECTION

At the designing stage of a cable winding system, please keep an eye on leaving enough distance between any changes of direction. The best and recommended distance should be at least 20 times the cable OD (even longer for high speed systems). This behavior will leave the cable to regain its starting shape before suffering another bending.

ELECTRICAL

ELECTRICAL PARAMETERS

Voltages
For the rated, operating and test voltages of cables, the definitions given in DIN VDE 0298, Part3, apply. Some of these are mentioned in table 2.
AC - alternating current
DC - direct current

Rated voltage
The rated voltage of an insulated electric cable is the voltage which is used as the basis for the design and the testing of the cable with regard to its electrical characteristics.
The rated voltage is expressed by the two values of power frequency voltage U_0/U in V.

- ***U_0 rms value between one conductor and "earth"***
- ***U rms value between two conductors of a multi-core cable or of a system of single-core cables***

In a system with AC voltage, the rated voltage of a cable must be at least equal to the rated voltage of the system for which it is used. This requirement applies both to the value U_0 and the value U.
In a system with DC voltage, its rated voltage must not be more than 1,5 times the value of the rated voltage of the cable.

Operating voltage
The operating voltage is the voltage applied between the conductors Electrical parameters and earth of a power installation with respect to time and place with trouble-free operation.

- *Cables with a rated voltage U_0/U up to 0,6/1 kV*
  These cables are suitable for use in three-phase AC, single-phase AC and DC installations, the maximum continuously permissible operating voltage of which does not exceed the rated voltage of the cables by more than 10% for cables with a rated voltage U_0/U up to and including 450/750 V 20% for cables with a rated voltage U_0/U = 0,6/1 kV.

- *Cables with a rated voltage U_0/U greater than 0,6/1 kV*
  These cables are suitable for use in three-phase and single-phase AC installations, the maximum operating voltage of which does not exceed the rated voltage of the cable by more than 20%.

- *Cables in DC installations*
  If the cables are used in DC installations, the continuously permissible DC operating voltage between the conductors must not exceed 1,5 times the value of the permissible AC operating voltage. In single-phase earthed DC installations, this value should be multiplied by a factor of 0,5.

Test voltage
Regarding the test voltage of flexible cables, the values given in the corresponding parts of DIN VDE 0250 apply.

ANCHORING SYSTEMS

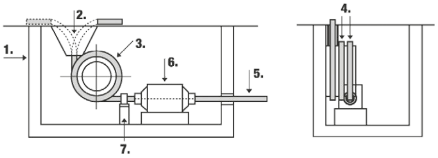
Correct cable anchoring is important in establishing reliable operation of a cable handling system. According to the cable handling system typology, different methods may be used, but all of them share the same basic intent: spread the tensile forces over a sufficient large cable sheath area in order to avoid damage or failures at the anchoring point.

The most common mobile anchor points are performed using the ordinary terminals or “cable grips”.
In these cases it is recommended that the tensile load would be distributed over an end length of the cable equal to 20/25 times its OD, and that a slack loop of cable will be left before entry into the terminal box in order to allow the operating movements.

When an underground centre point attachment is installed, the vertical distance between the entry bell and the crane’s payout guide should not be less than 15 times the cable OD or 1m, whichever is larger. At least 2 cable turns should be wound around the fixed stress relief drum to ensure sufficient contact area for an adequate stress relief.

Dynamic tensile stress on the cable can lead to premature failure, especially in high travel speed applications. In order to minimize this, several solutions are at hand, as the most important - according to our experience - is a travel speed reduction device. This system can be incorporated with most reel drive designs. It reduces the travel speed before reaching the centre point, and then re-accelerates once the centre point has been passed and the reel direction of rotation has been reversed.

Anchoring system for center crossover



1. Cable support
2. Entry bell
3. Stress bearing drum*
4. Cable wound twice ($2^{1/2}$) around stress bearing drum
5. Supply cable
6. Cable termination box
7. Clamp

*(for MV cables = 10 x OD; for LV cables= 5 x OD)

Table 2

Flexible Cable	Rated Voltage	Max Permissible Operating Voltage			Test Voltage Applied to the Complete Cable		
	Uo/U	in AC System Uom/Um	in DC System Vm kV	Single-Phase Earthed U kV	Power Cores kV	Control Cores kV	Pilot Cores kV
BasketHeavyFlex	300/500 V	318/550 V	0,825	0,413	2	-	-
Flexiflat	450/750 V	476/825 V	1,238	0,619	2,5	-	-
Festoonflex-LX / Panzerflex-L	0,6/1 kV	0,7/1,2 kV	1,8	0,9	3,5	2	-
Panzerflex-L VS / Panzerlite	3,6/6 kV	4,2/7,2 kV	10,8	5,4	11	2	2
	6/10 kV	6,9/12 kV	18	8	17	2	2
Panzerflex-ELX / Panzerflat-ELX	8,7/15 k1V	10,4/18 kV	27	14	24	2	2
	12/20 kV	13,9/24 kV	36	18	29	2	2
	18/30 kV	20,8/36 kV	54	27	43	2	2

CALCULATION OF CABLE CROSS SECTION

For the transmission of a given current under given operating conditions, the current carrying capacities for standard conditions of continuous operation discussed herewith must be adopted and necessary corrected.
Downwards adjustment may be required using correction factors for conditions relating to:

- ambient temperature
- number of layers and turns on reels
- number of conductors simultaneously under tension

It should not be forgotten that non continuous operation will mean better cable performance.

With the actual tendency to increase cable operating lengths it is wise to check voltage drop, not just for Low Voltages but for Medium to High Voltages too.

In some circumstances it may be necessary to check the resistance of the cable to short circuit currents both from a thermal view point and electro-dynamically induced forces.

CURRENT CARRYING CAPACITY FOR CONTINUOUS OPERATION

The values for current carrying capacity and various correction factors given in the below table are the same as those defined by standard VDE 0298 Part 4, 08-2003. Although the cables contained in this catalogue are insulated with ethylene propylene rubber (EPR) for which the admissible operating temperature for continuous operation is 90 °C, the current carrying capacities given here are for conductor temperature of 80 °C.

This is to conform to VDE standards and also as a precautionary measure to take into account greater difficulties with heat dispersion for this type of cable. The values are for three core cable, with or without earth conductor, not wound and resting on the ground with ambient air temperature of 30°C. For installations where it is known that the life of the cable will be reduced as a result of high mechanical stress or wear in the sheathing, then thermal ageing will be of less importance. In these cases a maximum operating temperature of 90 °C can be considered and the capacities given in table 3 can be increased by, approximately, 7%.

Courtesy of: REGGIANE CRANES and PLANTS - FANTUZZI GROUP - Italy

Courtesy of: REGGIANE CRANES and PLANTS - FANTUZZI GROUP - Italy

CABLE REELS

Cable life and performances is tightly connected to the reeling design. A well designed reeling system, combined with the correct choice of the cables, secures optimal performances of the whole system and also can assure long lasting operative cables, increasing their life and reliability.
Today's market uses a wide range of cable reels that can be summarized in three main types: you can find herewith a brief description of each one with some hints about their advantages and disadvantages.

Mono-Spiral reel

It is one of the most diffused. It has a simple guide route that gives - as a result - an extension to the cable's own life in comparison to the other types. Moreover on these cable reels (due to the improved heat dissipation), the conductor size for the power cables are generally smaller in comparison to the other kind of reels.
The cable diameter and length are main factors to be considered for the application on mono-spiral reels: the good balance between reel's inner and outer diameter, will be critical for determining and controlling the cable tension.

Random Wound reel

It is the simplest type amongst the existing cable reels: it operates without guides so the random layering can create severe operational difficulties such as slippage of coils, abrupt tensile forces, torsion, abrasions and abnormal build-ups. For these main reasons this application can support only small cable diameters and short runs: 250m maximum run, and a weight approx. < 4 kg/m.

Multi-spiral reel

It is indicated for large cable diameters and long lengths. The main advantage on using this type of reel is its ability to carry large amount of cable (even with large diameters) at a constant reeling tension and for long distances.
On the other hand, normally due to the reel location, is also difficult to reduce the number of guides and changes of direction on this type of installation.

HANDLING AND INSTALLATION

For optimum long life service, laying operations must be carried out by expert personnel. In addition to the normal measures to be observed when laying cables, the following recommendations, specific to the operating conditions for mobile cables, must be strictly adhered to. It's always a good practice to test the installation a few times as soon as the cable has been laid to check operation and immediately correct any eventual defects or faults.

HANDLING OF CABLE

Storing and handling of cables on the original drums is recommended in order to prevent the formation of defects caused by loose coils.

If possible avoid, or at least minimize, to roll the drums on its flanges: on the other hand, use a fork-lifter or crane to move the reel. If you cannot avoid rolling the drum, do it against the coiling direction not following. This small suggestion will keep the cable coiled tight to the reel and will prevent any torsion or abrupt tensions given by loose coil action.

A further recommendation regards storage. Spare cables have to remain on their original drums (it prevents coils slumping); moreover - even you consider either a short or long cable storage - the cables' drums must be kept in a cool, dry and shaded location and the cable's ends must be sealed (as done on first delivery) in order to prevent the entrance of moisture and dirt.

Table 3

Cables up to 10 kV — **CURRENT CARRYING CAPACITY**

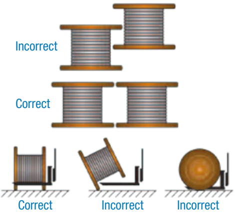
Cross-section mm²	Stretched Laying A Factor 1	Suspended Freely in Air A 1,05	1 Layer A 0,8	2 Layers A 0,61	3 Layers* A 0,49	Reeled in 4 Layers A 0,42	5 Layers A 0,34	6 Layers A 0,27	7 Layers A 0,22
1	18	19	14	11	9	8	6	5	4
1,5	23	24	18	14	11	10	8	6	5
2,5	30	32	24	18	15	13	10	8	7
4	41	43	33	25	20	17	14	11	9
6	53	56	42	32	26	22	18	14	12
10	74	78	59	45	36	31	25	20	16
16	99	104	79	60	49	42	34	27	22
25	131	138	105	80	64	55	45	35	29
35	162	170	130	99	79	68	55	44	36
50	202	212	162	123	99	85	69	55	44
70	250	263	200	153	123	105	85	68	55
95	301	316	241	184	147	126	102	81	66
120	352	370	282	215	172	148	120	95	77
150	404	424	323	246	198	170	137	109	89
185	461	484	369	281	226	194	157	124	101
240	540	567	432	329	265	227	184	146	119
300	620	651	496	378	304	260	211	167	136
Cables above 10 kV									
16	105		84	64	51	44	36	28	23
25	139		111	85	68	58	47	38	31
35	172		138	105	84	72	58	46	38
50	215		172	131	105	90	73	58	47
70	265		212	162	130	111	90	72	58
95	319		255	195	156	134	108	86	70
120	371		297	226	182	156	126	100	82
150	428		342	261	210	180	146	116	94
185	488		390	298	239	205	166	132	107
240	574		459	350	281	241	195	155	126
300	660		528	403	323	277	224	178	145

* The reduction factor is also valid for flat reeling cables (spirally).

DE-RATING FACTORS

The de-rating factors take into account the installation and operating conditions, such as temperature, grouping, intermittent periodic duty and the number of simultaneously loaded cores.
They are to be used for determining the current-carrying capacity in accordance with table 3.

FORK LIFTING OPERATING



CABLE INSTALLATION

Generally, when a cable is installed onto a force guidance system as the reeler, festoons, gravity-fed (spreader) basket, the transport drum should be jacked up above ground level.
The preferred method to operate a cable installation on site consist first of all in jacking up the original drum then unwinding the cable all along the entire machine's travel route. You can use conventional cable pulling equipment and rollers to perform this action.
Sometimes these procedures cannot be used due to the environment or site conditions so you can act transferring it directly from the drum to the reel. It is also a recommended method when reel location and/or cable runaway are not accessible. In this case you must avoid introducing "S" bending between the drum and the reel. Whenever possible the cable should be transferred directly without passing through or over any rollers or change of directions.
The directly transferring from the transport drum to the final reel must be done slowly and with a minimum tension: this behavior would avoid any torsional influence during cable installation.

The following pictures show how to proceed generally when unreeling the cable from the original drum and transferring it directly to the final operating system.

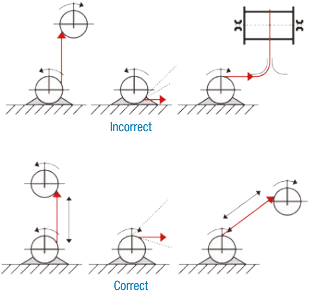


Table 4

DE-RATING FACTORS FOR VARYING AMBIENT TEMPERATURES

Ambient Temperature °C

10	15	20	25	30	35	40	45	50	55	60	65	70
1,18	1,14	1,10	1,05	1,00	0,95	0,89	0,84	0,77	0,71	0,63	0,55	0,45

Table 5

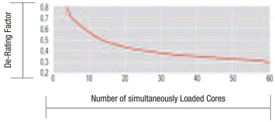
DE-RATING FACTORS FOR GROUPING

Arrangement	Number of multi-core cables or number of single or three-phase circuits made up of single-core cables (2 or 3 loaded conductors)														
	1	2	3	4	5	6	7	8	9	10	12	14	16	18	20
Bunched directly at the wall, the floor, in conduit or ducting, on or in the wall	1,0	0,8	0,7	0,65	0,6	0,57	0,54	0,52	0,5	0,48	0,45	0,43	0,41	0,39	0,38
Single layer on the wall or floor, touching	1,0	0,85	0,79	0,75	0,73	0,72	0,72	0,72	0,71	0,70					
Single layer on the wall or floor, spaced with a clearance of 1 x cable diameter between adjacent cables	1,0	0,94	0,9	0,9	0,9	0,9	0,9	0,9	0,9	0,9	0,9	0,9	0,9	0,9	0,9
Single layer under ceiling, touching	0,95	0,81	0,72	0,68	0,66	0,64	0,63	0,62	0,61						
Single layer under ceiling, spaced with a clearance of 1 x cable diameter between adjacent cables	0,95	0,85	0,85	0,85	0,85	0,85	0,85	0,85	0,85	0,85	0,45	0,85	0,85	0,85	0,85

Table 6

DE-RATING FACTORS FOR MULTI-CORE CABLES WITH CONDUCTOR CROSS-SECTIONS UP TO 10 mm^2

Number of loaded cores	De-Rating Factors
5	0,75
7	0,65
12	0,53
18	0,44
24	0,40
30	0,37
36	0,36
42	0,35
61	0,30



Twist removal

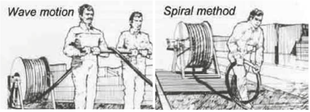
If, during the above procedure, the cable has become twisted, we strongly recommend to eliminating it. Normally two methods are foreseen to perform this action.

Wave Motion

Insert a cylinder roller (the diameter of which should be between 15/20 cm) underneath the cable near to the twisting. At this point two people should walk handling the roller and pushing the “wave” towards the end of the cable.
You can perform this action until the detected twist is removed.

Spiral Method

This could be carried out by one person only and will reach the same effect described above. Allow enough cable from the fixed end of the cable (better from the drum jacked on) in order to obtain a spiral. This should be a right side or a left side one according to the direction of the detected twist.



The spiral will be rolled to the free end of the cable in order to remove any twisting. This action must be performed again for each founded twisting. Then re-anchor the cable to start operation. If during the first test-running of the equipment you still find a slight or residual twisting, lead the machine to the end run then un-anchor the cable (eventually cutting 25/50cm of cable) and eliminate the torsion. After this, re-anchor the cable and have a final check.
Please keep in mind that a cable correctly installed, if no torsions are introduced by guides or unnatural bending, it cannot twist (for an evident physical law).
For this reason we suggest that during the final check, you draw some marks on the cable than let the machine run in order to can easily determinate if the cable starts to twist.
If yes the whole system has to be stopped in order to find and eliminate the external cause of the torsion.

Note: the cable marking can show a natural slight spiral effect
(more evident on long cable lengths), but this aspect is totally not related to any kind of twisting problem.

CURRENT CARRYING CAPACITIES FOR NON CONTINUOUS OPERATION

In some cases electrical operation is not continuous or it is only partially continuous. It may therefore be advisable to check the values for current circulating and operating times, to see whether the cross section of the cable can be reduced.

A typical example of intermittent operation with hoisting equipment consists of repeated cycles where, for example, an operating period of 10 minutes of full load is followed by a longer period with no load.
These 10 minutes taken as a percentage of total duration DT of the cycle provides provides a percentage load factor.

Load Factor FC % = (10 mi / DT) x 100

In this case the current carrying capacity as calculated using table 3, can be increased using factors given in table 7.

Table 7

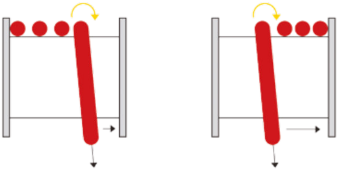
CORRECTION FACTORS FOR INTERMITTENT OPERATION

Cable Cross Section (mm^2)	1,5	2,5	4	6	10	16	25	35	50	70	95	120	150	185	240	300
Load Factor (FC%)	CORRECTION FACTORS															
60%	1,00	1,00	1,00	1,00	1,03	1,07	1,10	1,13	1,16	1,18	1,20	1,21	1,22	1,23	1,24	1,25
40%	1,00	1,00	1,03	1,04	1,09	1,16	1,23	1,28	1,34	1,38	1,42	1,44	1,46	1,48	1,49	1,50
25%	1,00	1,02	1,05	1,13	1,21	1,34	1,45	1,53	1,62	1,69	1,74	1,78	1,81	1,82	1,85	1,87
20%	1,00	1,04	1,11	1,18	1,31	1,45	1,59	1,69	1,79	1,87	1,93	1,97	2,01	2,04	2,10	2,15
15%	1,00	1,08	1,19	1,27	1,44	1,62	1,79	1,90	2,03	2,13	2,21	2,26	2,30	2,32	2,36	2,39

Cable installation on multi-spire reels

PANZERFLEX crane cables are manufactured with right hand lay-up of the conductors (power and control cable) and therefore when winding onto multi-spiral reels, the first turn must be with the cable against the right flange of the reel.

This will have the effect of exploiting the natural tendency of the cable under traction to move to the right, keeping subsequent turns close together.



Incorrect Correct

To assist the movement of the cable over guide rollers, sheaves, etc. a dry lubricant or a silicone based grease may be used as these types of lubricants avoid dust and dirt from adhering to the lubricated surface.

SHORT CIRCUIT CURRENT

THERMAL limit of short circuit

In accordance with VDE standards 0250 c.8/75 the admissible THERMAL limits for short circuit current in heavy duty mobile service cables, must be calculated using the following reference values:

Initial = 80 °C (cable under full load)
Final short circuit temperature = 200 °C

The short circuit currents (thermal limit) given in the below table 8 have been calculated using these reference values and are valid for a base time of 1 sec.

For other time periods, taking into account the protection characteristics of the apparatus, the value in the table must be divided by the square root of the effective time (in seconds).
For different initial and final temperatures (i.e. with 90 °C and 250 °C admissible according to standards for EPR), the short circuit current (thermal limit) can be calculated using the following formula:

$$Icc\ (A) = \frac{kcc \times \text{cond. cross section } (mm^2)}{\sqrt{t}\ (sec)}$$

where the coefficient kkc assumes the values in table 9.

Table 8

SHORT CIRCUIT CURRENT

Nominal Cable Cross Section (mm^2)	One Second Thermal Limit for all Voltages (kA)
1,5	0,20
2,5	0,32
4	0,51
6	0,77
10	1,29
16	2,06
25	3,22
35	4,50
50	6,43
70	9,00
95	12,2
120	15,4
150	19,3
185	23,8
240	31,0

Courtesy of: REGGIANE CRANES and PLANTS
FANTUZZI GROUP - Italy

Table 9

COEFFICIENT kcc FOR DIFFERENT INITIAL AND FINAL TEMPERATURES

Final Short Circuit Temperature in °C	INITIAL SHORT CIRCUIT TEMPERATURE						
	30 °C	40 °C	50 °C	60 °C	70 °C	80 °C	90 °C
	COEFFICIENT kcc						
160	143	136	129	122	115	107	100
200	159	153	147	141	135	128	122
250	176	170	159	159	154	148	143

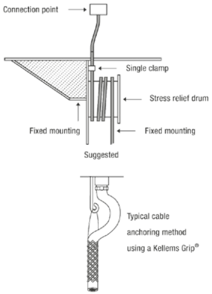
CABLES INSTALLATION FOR VERTICAL APPLICATION

(BASKETHEAVYFLEX, PANZERFLEX-L VS, PANZERLITE)

Anchoring systems

Cables installation on a spreader or other kind of vertical application, needs to follow some major attention, mainly due to the specific kind of application.
Main recommendations given in the previous paragraphs (wound the cable from the original drum; avoid to subject the cable to unnecessary loops, torsion or twisting; eliminate any eventual torsion, etc.) must be followed also for these cables. Moreover the installation has to go after all the topics given herewith.

The best anchoring is achieved with a stress relief drum as shown on the below picture. The open ended construction facilitates installation and replacement while affording better stress relieve and sheath protection than cable grips. In this case at least 2 cable turns should be wound around the drum. The table “Bending radii” shows the minimum bending radii of stress relief. If, on the other hand, the anchoring would be made with a grip, a recommended length of coverage over the cable is 20/25 times the cable OD. This will aid in spreading the dynamic stresses over a sufficient sheath surface area to inhibit cable damage.



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Fix the bottom

When necessary, the bottom of these cables would be fixed by a suitable grip. The sheath coverage is the same of the anchoring system (20/25 OD of the cable). The distance from the end of anchoring device to the end of the machine travel should be at least 40 x cable OD. If frequent dynamic stresses near the anchor point are anticipated a spring may be used.

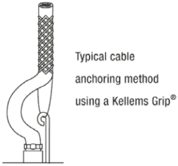

Table 10

VOLTAGE DROP CALCULATION

Nominal Cross section mm²	A.C. Resistance at 50Hz and 80 °C (R) Ohm/km	Reactance at 50 Hz for Three Core Cable (3 phase + earth) at Operating Voltage ≤ 0,6/1 kV (X) Ohm/km	3,6/6 kV (X) Ohm/km	6/10 (X) Ohm/km	8,7/15 (X) Ohm/km	12/20 (X) Ohm/km
1,5	16,9	0,103				
2,5	10,1	0,095				
4	6,29	0,092				
6	4,19	0,086				
10	2,41	0,083				
16	1,53	0,078				
25	0,983	0,078	0,106	0,107	0,114	0,123
35	0,699	0,075	0,100	0,101	0,107	0,116
50	0,486	0,075	0,095	0,097	0,102	0,110
70	0,343	0,073	0,090	0,092	0,097	0,104
95	0,261	0,072	0,087	0,088	0,093	0,099
120	0,204	0,071	0,084	0,085	0,089	0,095
150	0,165	0,071	0,082	0,083	0,087	0,092
185	0,136	0,071	0,080	0,081	0,085	0,090
240	0,104	0,070	0,079	0,079	0,083	0,087

ELECTRICAL PARAMETERS

Three phase voltage drop

Voltage drop should be checked not just for Low Voltage but also for Medium Voltage connections where lengths are long. The value is calculated by multiplying the factors K (mV/Am) of the cable then by the length of the connection L (in km).

The formula to calculate the voltage drop is the following:

$$V = I \times L \times K \text{ (Volt)}$$
$$\text{where } K = 1{,}73 \times (R \cos\varphi + X \operatorname{sen}\varphi)$$

I = (A) effective current capacity
L = (km) length of the connection
R = (Ohm/km) a.c. conductor resistance at 80 °C (see table 10 above)
X = (Ohm/km) cable reactance at 50 Hz (see table 10 above)

Values for electrical resistance R (80°C) and for reactance X (calculated for round cables, 3 cores + 3 earth, but valid also for flat cables with sufficient approximation) are also given in the above table 10.

It should be noted that for conductor temperatures of 90 °C the resistance R must be multiplied by 1,03 while for a frequency of 60Hz the reactance X must be multiplied by 1,2 and the value for (mV/Am) recalculated.