Prospective short Circuit current

Cable catalogue တခုတင်ပေးလိုက်တာစိတ်ဝင်စားသူအတော်များလို့အားရမိပါတယ်။

Cable များရဲ့ current rating သည်အပူချိန်30 degree centigrade အတွက်ဖြစ်ပြီး ပူလာလျှင် derating တန်ဘိုးချရမယ်။မြေကြီးမှာမြှုတ်ရင် ground temperature 15 deg;C ထက်ပိုရင် တန်ဘိုးလျှော့ရမယ်။ မြောင်းတူး cable ထည့်ပြန်ဖို့ဆိုတာနည်းစံနစ်မဟုတ်ဘူး။ Cable trunk ထဲကို ဆန့်သလောက် ထည့်ရ တာမဟုတ်ဘူး။ Cable ချတဲ့နည်းစံနစ်နဲ့ cable အရေအတွက်အပေါ်မူတည်ပြီး တန်ဘိုးလျှော့ရမယ် ဆိုတာ တွေသတိပြုမိစေလိုတာပါ။

လေ့လာပြီး နားလည်ပြီးဖြစ်သူတယောက်ရဲ့ဆွေးနွေးမှုကြောင့်ထပ်ပြီးဖြည့်စွက်ပေးလိုက်ပါတယ်။ တချို့catalogue များမှာ mv/A/m နဲ့ တချို့မှာ mohm/km ဖေါ်ပြပါတယ်။သုံးစွဲသူများလွယ်ကူအောင် catalogue များမှာဖေါ်ပြကြတာမို့ catalogue များကိုလေ့လာကြစေလိုပါတယ်။Prospective short circuit (kA) တွက်ရာမှာ sorce နဲ့အကွာအဝေး၊သုံးတဲ့ cable ရဲ့mili ohm/km သုံးပြီးတွက်ရပါတယ်။

စာမျက်နှာ၂ မှာ Transformer ရဲ့ capacity (KVA) နဲ့ တွက်ချင်တဲ့နေရာနဲ့Transformeအကြား resistance သိရင်ကြည့်ရှုနဲ့သိနိုင်မဲ့ Graph, Cable size အလိုက်ခုခံမှုဖေါ်ပြတဲ့ဇယားတခု ဖေါ်ပြထား ပါတယ်။ စာမျက်နှာ ၃ မှာTransformer ရဲ့ KVA, % inpedance of transformer များအသုံးပြုတွက် နိုင် တဲ့ Formula နဲ့ Resistance တွက်နည်းများဖြစ်ပါတယ်။Harvell's switchgear မှကူးပေးပါတယ်။

စာမျက်နှာ ၄ မှာ XLPE cable နဲ့ စာမျက်နှာ ၅ မှာ PVC cable တို့ရဲ့ cable size အလိုက် short circuit current ခံနိုင်ရည်ကိုတွက်ယူနိုင်တဲ့ Formula အပြင် မတွက်ဘဲသိနိုင်တဲ့ ဇယားဖေါ်ပြထား ပါတယ်။ စာမျက်နှာ ၆ မှာသိသင့်တဲ့ အချက်တွေဖြစ်ပြီး အဓိက copper and aluminium cable တို့ရဲ့ size (mm2) အလိုက် DC resistance ohm/km ဖြစ်ပါတယ်။ Sigma cable catalogue မှဖြစ်ပါတယ်။

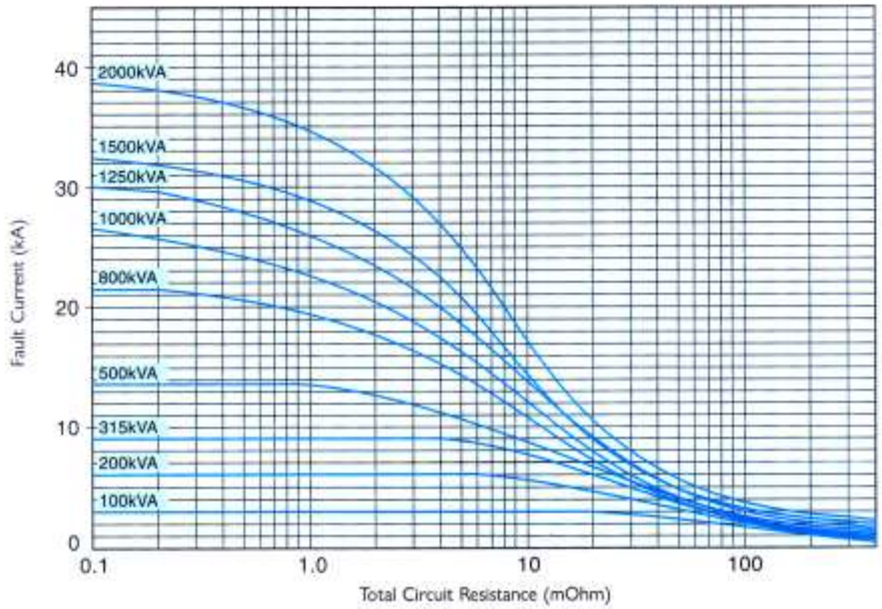
စာမျက်နှာ ၇ မှာ XLPE, PVC နဲ့ အခြား cable အမျိုးအစားများရဲ့ characteristic, property များကိုနှိုင်းယှဉ်ဖေါ်ပြထားပါတယ်။စာမျက်နှာ ၈ မှာ XLPE cable handling ဖြစ်ပါတယ်။cable ကိုင်တွယ်ရာမှာသတိပြုရမဲ့အချက်များဖြစ်ပါတယ်။

လေ့လာသင့်တဲ့အချက်တွေကိုဖေါ်ပြတာသာဖြစ်ပြီး ပြည့်စုံအောင်ဆက်လက်လေ့လာကြပါ။

တတ်သိနားလည်ကြပါစေ။

ဦးမြင့်ဦး

Estimating the Prospective Short Circuit Current



Maximum Resistance of Copper Conductors at 20°C (μOhm)

Nominal Cross-sectional Area (mm^2)	Cable Length											
	5m	10m	15m	20m	30m	40m	50m	60m	70m	80m	90m	100m
1	90.50	181.00										
1.5	60.50	121.00	182.00									
2.5	37.10	37.10	74.10	111.00	148.00							
4	23.10	46.10	69.20	92.20	138.00							
6	15.40	30.80	46.20	61.60	92.40	123.00						
10	9.15	18.30	27.50	36.60	54.90	73.20	91.50	110.00				
16	5.75	11.50	17.30	23.00	34.50	46.00	57.20	69.00	80.50	103.50		
25	3.64	7.27	10.90	14.50	21.80	29.10	36.40	43.60	50.90	58.20	65.40	72.70
35	2.62	5.24	7.86	10.48	15.70	21.00	26.20	31.40	36.70	41.90	47.20	52.40
50	1.94	3.87	5.81	7.74	11.60	15.50	19.40	23.20	27.10	31.00	34.80	38.70
70	1.34	2.68	4.02	5.36	8.04	10.70	13.40	16.10	18.80	21.40	24.10	26.80
95	0.96	1.93	2.10	3.86	5.79	7.72	9.65	11.60	13.60	15.40	17.40	19.30
120	0.77	1.53	2.30	3.06	4.59	6.12	7.65	9.18	10.70	12.20	13.80	15.30
150	0.62	1.24	1.86	2.48	3.72	4.96	6.20	7.44	8.68	9.92	11.20	12.40
185	0.49	1.00	1.49	1.98	2.97	3.96	4.96	5.96	6.94	7.93	8.92	9.91
240	0.34	0.75	1.13	1.51	2.26	3.02	3.77	4.52	5.28	6.03	6.79	7.54
300	0.30	0.63	0.90	1.20	1.80	2.80	3.00	3.61	4.21	4.81	5.41	6.01
400	0.23	0.47	0.70	0.94	1.41	1.88	2.35	2.85	3.29	3.76	4.23	4.70
500	0.18	0.37	0.55	0.73	1.10	1.46	1.83	2.20	2.56	2.93	3.29	3.66
630	0.14	0.28	0.42	0.57	0.85	1.13	1.42	1.78	2.15	2.51	2.88	3.25

FEEDER / CABLE PROTECTION

An estimation of the prospective short-circuit current (psc) in an installation is an important consideration in the selection of the appropriate protective device.

The magnitude of the short-circuit current (rms value of the AC component) at a point in the installation will depend upon;

(A) Prospective short-circuit current at the origin of the installation.

(B) The amount of resistance in the circuit between the origin of the installation and the point at which the short circuit occurs.

(C) The type of short-circuit, phase to phase or phase to earth or phase to neutral.

It is possible to arrive at a maximum prospective short circuit value at the origin by taking the transformer kVA rating and its impedance and calculating from the expression :

$$SC\ kA = \frac{\text{Transformer rating (kVA)} \times 100}{\sqrt{3} \times \text{Secondary voltage} \times \%\ \text{impedance of transformer}}$$

To calculate the resistance in the LV circuit, obtain details of lengths and sizes of cables between the source of supply and the point under calculation. Using the table provided, determine the sum of cable resistances and then simply read off the estimated fault current from the relevant transformer curve on the graph.

The values assume a symmetrical fault across the three phases. a single circuit, for line to neutral faults, take the cable resistance value from the table and double it.

The selection of Loadline MCCB for feeder /cable protection depends on the total load to be protected and the prospective short-circuit current (psc) at the point of installation.

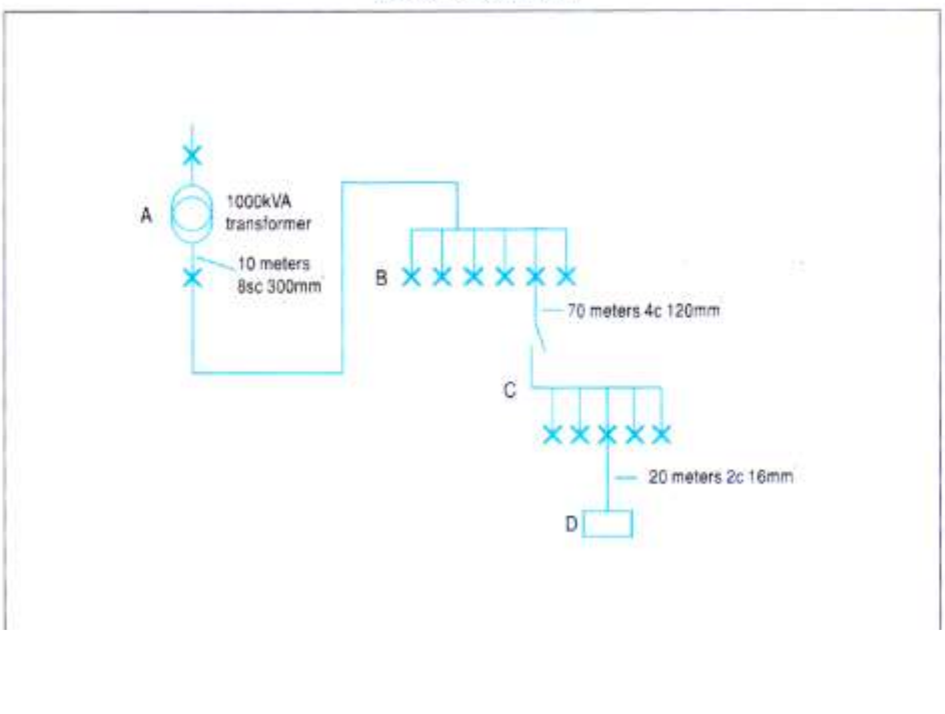
PSC at A	approximately 27kA
PSC at B resistance A to B (a)	 0.30mΩ = 25kA
PSC at C +resistance A to B +resistance B to C1	 0.30mΩ 10.70mΩ 11.00mΩ = 12kA
PSC at D +resistance A to B +resistance B to C +resistance C to D	 0.30mΩ 10.70mΩ 46.00mΩ (b) 57.00mΩ = 3kA

(a) 2 cables per phase divided by 2

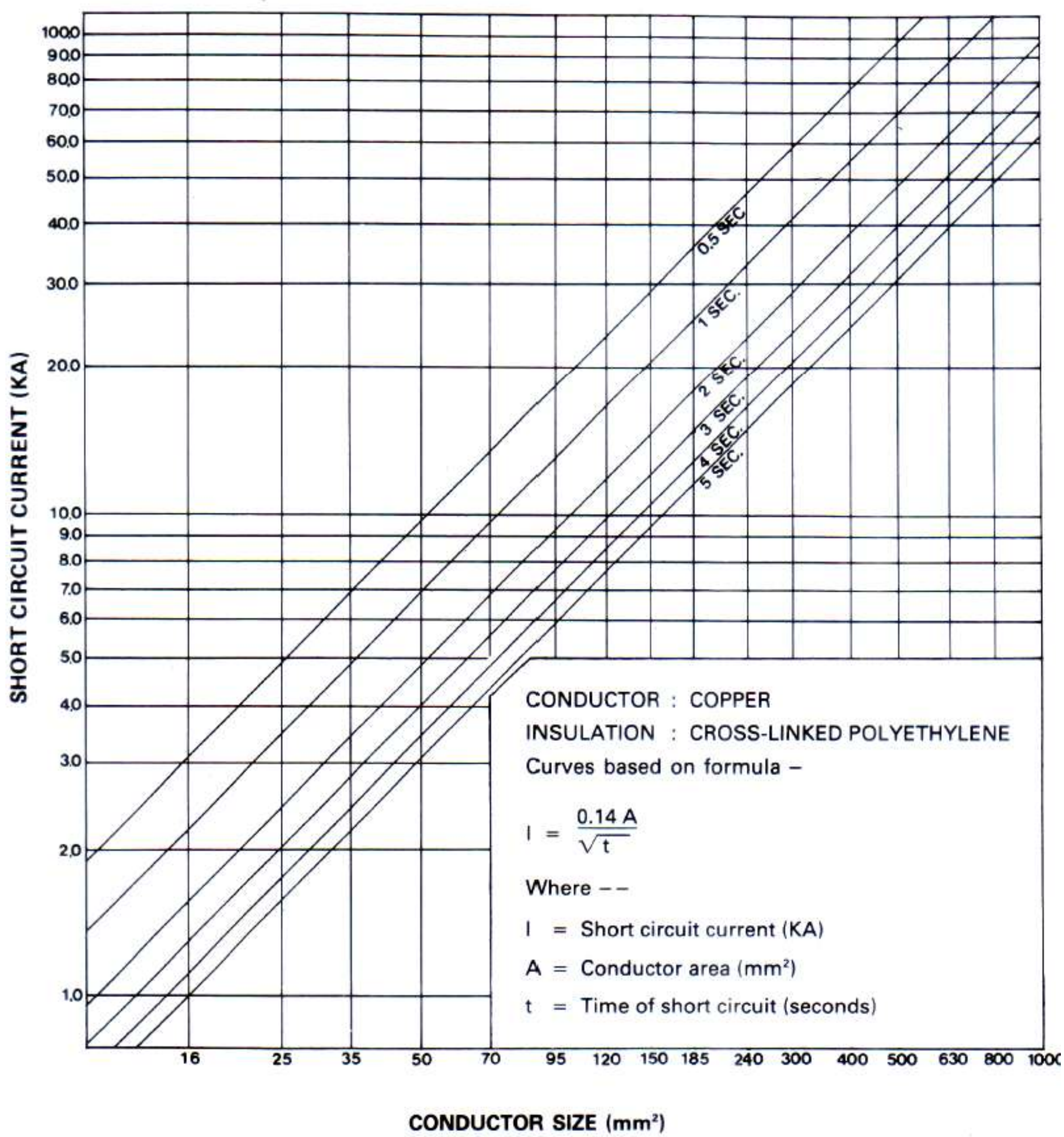
(b) 2 core cable, multiplied by 2

The above calculations have an inbuilt safety margin as they assume a no impedance fault condition which would not be the case in practice.

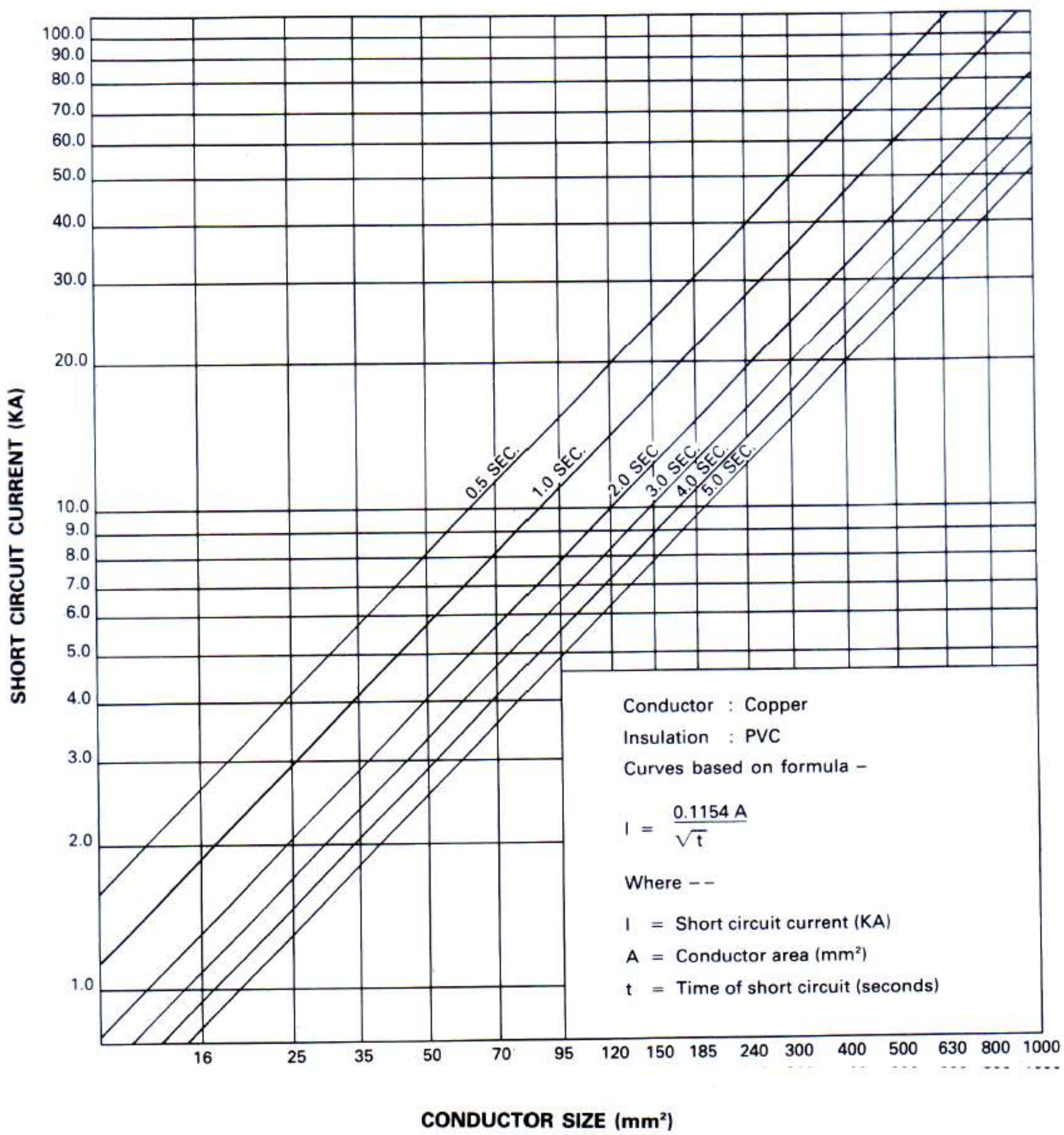
Typical Installation



Allowable short circuit currents for XLPE insulated cables



Allowable short circuit currents for PVC insulated cables



APPENDIX

Table 1

Typical Properties of Various Insulation materials

Insulation	Specific Gravity	Relative Permitivity	Thermal Resistivity (°C m/w)	Volume Resistivity at 20°C(ohm-cm)	Max. Cond. Temp. (°C)	Max. Short Circuit Temp. (°C)
PVC	1.44	5.0 – 8.0	5.0 – 6.0	10^{14}	70	160
PE	0.92	2.3	3.5	10^{16}	70	130
XLPE	0.92	2.5	3.5	10^{16}	90	250
EPR	1.20	3.0	3.5 – 5.0	10^{15}	90	250
Impregnated paper	1.10	3.3 – 3.9	6.0	10^{15}	65 – 80	160 – 250

Table 2

Properties of Conductors

Properties	Unit	Aluminium	Annealed copper
Density	g/cm^3	2.703	8.89
Volume Resistivity	ohm mm^2/Km	28.264	17.241
Coefficient of Resistance	Per °C	0.00403	0.00393
Melting Point	°C	660	1083
Coefficient of expansion	Per °C x 10^{-6}	25.5	16.8
Ultimate Tensile Strength	N/mm^2	205	275

Table 3

Stranded Conductors for Single-core and Multicore Cables

Nominal Cross-sectional Area		Maximum DC Resistance of Conductor at 20°C		Nominal Cross-sectional Area		Maximum DC Resistance of Conductor at 20°C	
		Copper Conductor	Aluminium Conductor			Copper Conductor	Aluminium Conductor
mm^2	No./mm	ohm/km	ohm/km	mm^2	No./mm	ohm/km	ohm/km
1.5	{1/1.38, 7/0.53}	12.1	–	120	37/2.03	0.153	0.253
2.5	{1/1.78, 7/0.67}	7.41	–	150	37/2.25	0.124	0.206
4	7/0.85	4.61	7.41	185	37/2.52	0.0991	0.164
6	7/1.04	3.08	4.61	240	{37/2.88, 61/2.25}	0.0754	0.125
10	7/1.35	1.83	3.08				
16	7/1.70	1.15	1.91	300	61/2.52	0.0601	0.100
25	7/2.14	0.727	1.20	400	61/2.85	0.0470	0.0778
35	19/1.53	0.524	0.868	500	61/3.20	0.0366	0.0605
50	19/1.78	0.387	0.641	630	127/2.52	0.0283	0.0469
70	19/2.14	0.268	0.443	800	127/2.85	0.0221	0.0367
95	19/2.52	0.193	0.320	1000	127/3.20	0.0176	0.0291

Conversion Table

	Circular mil (CM)	Square inch in^2	Square millimeter mm^2
1 Circular mil = (CM)	1	7.85398 x 10^{-7}	5.06707 x 10^{-4}
1 Square inch =	1.27324 x 10^{6}	1	645.16
1 Square millimeter = mm	1973.53	1.55000 x 10^{-3}	1

Note: 1 MCM = 1000 CM

CHARACTERISTICS OF CROSSLINKED POLYETHYLENE

It is well known that polyethylene is superior in electrical characteristics and chemical resistance, but it has a defect of melting point at the temperature of 110℃.
Crosslinked polyethylene, which results from a chemical process of "cross-linking" of the molecular structure, has eliminated this defect of melting point.
Cross-linked Polyethylene insulation for cables is extruded and vulcanized in roughly the same way as rubber insulation. The XLPE material is formed concentrically over the conductor in the extruder head. Chemical cross-linking of the polyethylene molecular takes place with the aid of organic peroxides mixed with the PE material. During the vulcanization, the peroxides disintegrate cross-linking of the PE molecules. Due to its molecular structrue, it has excellent ozone resistance and outstanding heatstability and resistance. The features of cross-linked polyethylene are as mentioned below in brief.

(1) High softening temperature and small heat distortion
(2) High mechanical strength under high temperature.
(3) Superior heat aging resistance.
(4) High resistance against stress cracking.
(5) Superior electrical characteristics.
(6) Light in weight.

Table 1. Characteristics of Plastics and Rubbers used for Wire & Cable

Item \ Material	Crosslinked Polyethylene	Polyethylene	PVC	Butyl Rubber	EP Rubber	Polychloroprene
Specific gravity	0.92	0.92	1.2~1.5	1.4~1.5	1.3~1.4	1.4~1.6
Dielectric strength(kv/mm)	30~50	30~50	20~35	20~30	30~45	15~25
Volume resistivity(ohm-cm)	10[illegible]	10[illegible]	10[illegible]	10[illegible]	10[illegible]	10[illegible]
Dielectric constant	2.3	2.3	5~9	4~5	4~5	7~10
Power factor(%)	0.03	0.03	4~12	1~3	1~2	Not more than 10
Tensile strength(kg/mm²)	1.4~1.8	1.2~1.5	1.0~2.5	0.4~0.7	0.4~0.9	1.2~2.0
Elongation(%)	500~600	500~600	100~300	300~600	400~650	300~600
Max. operating Temperature(℃)	90	75	60~75	80	90	75
Flame resistivity	NG	NG	E	NG	NG	E
Heat deformation	F	G	G	G	F	G
Ozone resistivity	F	F	G	F	E	G
Weather proof	G	G	F	F	F	F
Oil resistivity	E	E	F	NG	NG	G

E:Excellent F:Fine G:Fairly good NG:Unsuitable

Table 2. Max. Allowable Conductor Temperature

Insulation Type	Normal Operation	Short-Circuit Condition
PE Cable	70℃	130℃
XLPE Cable	90℃	250℃

Crosslinked PE Insulated PVC Sheathed Power Cables

HANDLING

4. Minimum bending radius and permissible maximum pulling tension

For safety installation without damaging electrical and physical properties, the following minimum bending radius and permissible maximum pulling tension must be observed:

Minimum bending radius

Type of cable \ Number of core	Single core		Multi core
	Round conductor	Four segmental stranded conductor	
600V cable	8D	12D	6D
3,300V cable and higher	10D	12D	8D
Triplex type cable	—	—	8D
Corrugated metal armoured cable	10D	12D	8D
Flat tape armoured cable	10D	12D	8D
Wire armoured cable	10D	12D	8D
Lead sheathed cable	10D	12D	10D

Permissible Maximum Pulling Tension

Pulling tool	Material of conductor	Permissible maximum pulling tension(kg)
Pulling eye	Copper	7 × (Number of core) × (Cross-sectional area of conductor)
	Aluminium	14 × (Number of core) × (Cross-sectional area of conductor)
Cable grip	Copper & aluminium	The same as using the pulling eye, but the maximum tension should be less than two tons.

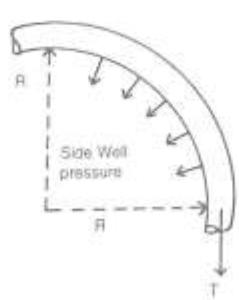
Note: When cable grip is used it should cover more than 500 mm in length of the cable end and be bound to the cable sheath.

5. Side wall pressure to cable

Permissible maximum side wall pressure to the cable at bending point during installation is 500 kg/m.

$$\text{Side wall pressure to cable} = \frac{T}{R}$$

T : Pulling tension (kg)
R : Bending radius (m)



6. Removal of sheath or tape

Special care must be taken not to harm the insulation When removing the sheath or tapes with a knife otherwise it may result in a dielectric breakdown.

7. Cleaning the surface of insulation

The surface of insulation should be cleaned to avoid a flash over at the cable termination or joint.

8. Applying of self adhesive tape

When applying a self adhesive tape after jointing or terminating of XLPE cable, stretch it properly about 1.2 times as long as the original one. If it is overstretched crack may occur on the tape in the long run and if not stretched properly, tape will be adhered between each layer.

9. Water proof treatment for out-door termination

For out-door termination water proof treatment is necessary to avoid the water penetrating into the cable end and special care must be taken to apply tapes end terminals.