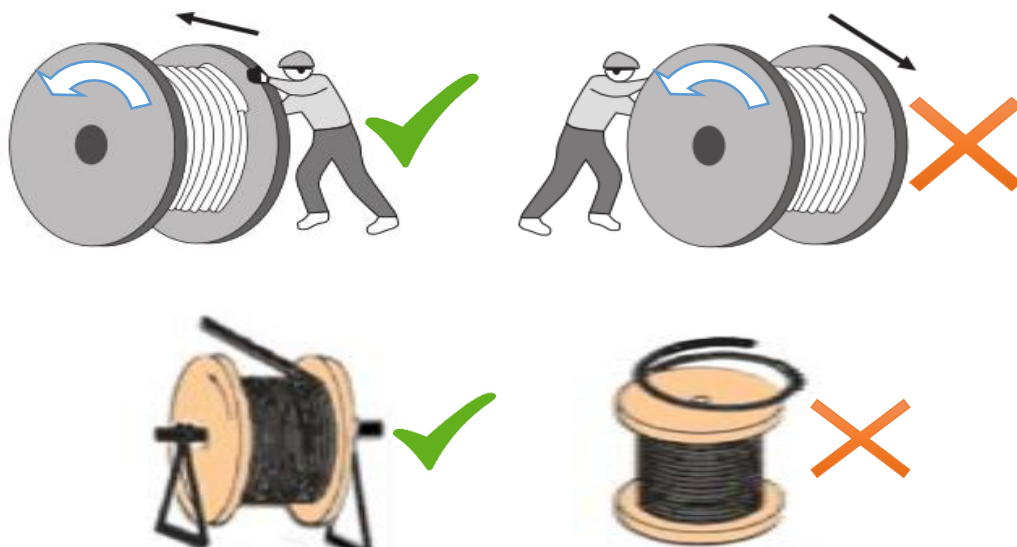


HANDLING, PULLING AND LAYING INSTRUCTIONS PROCEDURE

A. CABLE HANDLING, PULLING AND LAYING

1. It is recommended to dig a trial hole in the cable route which shall indicate the position of other services and a smooth bend can be provided to reduce the pulling load on the cable.
2. Drum flange bolts should be inspected and tightened before pulling and laying.
3. Due to interdicted stress during transportation, nails used to fix the two layers of a flange might be forced to shift into the inner side of a drum. Drums damaged or overstressed (e.g. dropped on a flange) needed to be checked carefully. Is in question have to be removed by pliers before rolling or turning the drum to avoid continuous damages of outer sheath by rotating cable layers.
4. During opening the wooden lagging, if there is a nail that went into the rolls of cable must be taken, this would make the defects in the cable.
5. Cable should be inspected before laying to ensure that free from damages.
6. Location of drum prior to pulling can be decided based on minimum pulling tension which can be achieved.
7. Drums should be normally mounted so that the cable is pulled from the top of the drum and for very heavy cables it may be necessary to use a ramp to support the cable during passage into the trench.



Picture 1. Roll direction

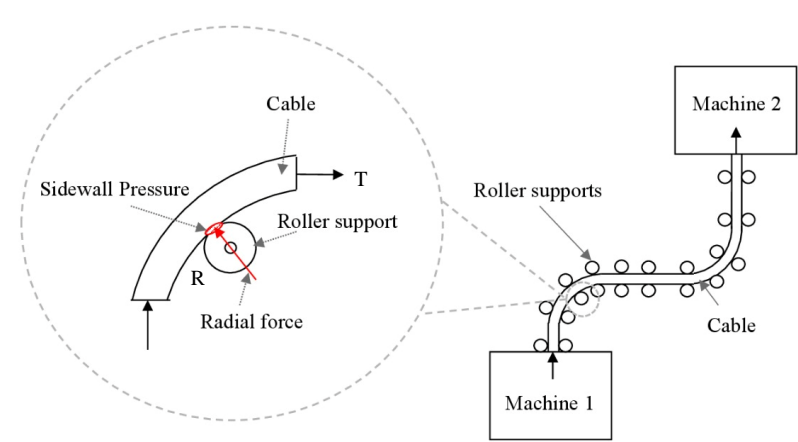
8. The cable should preferably be drawn to its final position in a continuous manner. During stops, it will settle between rollers and may cause high strain on machines during restarting.
9. When pulling cables beside existing cables, special care should be taken to avoid damage to the existing cables.
10. Precautions should be taken such as clearing all excavated material from the trench edges, using vertical timbers etc, so that no stones or sharp objects shall fall onto the cable.
11. If not specified in the Technical Data Sheet, the minimum permissible bending radius shall be as per Table 1 and Table 2.
12. If not specified in the Technical Data Sheet, the maximum pulling tension should be as per Table 4.
13. Side wall pressure at the bend should not be exceeded.
 - For allowable side wall pressure :
 Permissible maximum side wall pressure to the cable at bending point during installation is 500 kg/m.

Note:

$$\text{Side wall pressure to cable} = \frac{\text{pulling tension (kg)}}{\text{bending radius (m)}} = \frac{T}{R}$$

T : Pulling tension (kg)

R : Bending radius (m)



Picture 2. Side wall pressure

14. Possibility of breaking the drum anytime should be prepared as in sudden stoppage of cable pulling. Continuation of drum rotation can cause sharp bending of the cable.
15. If found any loose nails on the inside of the flange, they must be removed because they could easily cause damage to the cable sheath.
16. If a nail hat is found sticking out of the inner flange of the cable drum, the cable pulling must be stopped immediately and the nails shall be removed to avoid defects in the cable. The nail hat sticking out of the inner flange of the cable drum is caused by shifts of the 2 wooden flange layers against each other under interdicted force while moving the drum.
The longer the cable per drum and the heavier the cable per drum caused the greater potential for the nail hat to come out of the flange of the cable drum, so it is recommended that when pulling the cable there are personnel waiting at the pay off area to monitor the movement of nails and drum rotation.
17. Make sure condition of the brake of pay off running properly. If the brake on the pay off is not proportional so that when the pulling is stops, the drum is still rotating so causing bent cables or loose coils.
18. Normally when pulling the cable there is a movement of the inner end of the cable out of the drum hole, but if the inner end of the cable is still attached to the nylon cord then the movement is restrained which causes the cable to bend. When starting cable pulling, make sure the inner end of the cable is removed from the ties or clamps.
19. Depth of laying shall be as per relevant standard.
20. Layer of sand 100 - 150 mm approx. under and over the cable shall be finished. Then a layer of brick or tile shall be placed for warning, mechanical protection, load distribution.
21. When pulling the cable inside conduit/pipe the inner diameter of the pipe shall be minimum 1.5 times the cable diameter (Table 3).
22. It is preferable to use pipe with funnel shape, cable should not rest at the sharp edges of the pipe, special care should be taken such that stones and other objects are not dragged with the cable inside the pipe.
23. Pipe should be cleaned before pulling operation.
24. Special lubricant can be used to minimize the cable friction with the pipe wall.
25. When cables of different voltages are laid together it is preferable that the higher voltage to be laid down, then the lower voltage and then lower voltage.

- Highvoltage cables should be separated by a covering slab from the other cables.
26. For direct buried installations, rollers at a distance of around 1-2 meters are to be used based on cable weight, in any case cable should not touch the ground, it is recommended to use motorized rollers at the distance of 20 M to 30 M with proper monitoring. These are beside the normal cable rollers specially near bending points so that the cable pulling force shall be distributed evenly over the complete length of the cable. This kind of pulling is recommended when there are many bends in the cable route.
 27. For cable pulling, cable stocking can be used for Steel Wire armored cables while for non armored cables and Steel Tape armored cables pulling head is preferred. Special care shall be taken to seal the cable head avoiding water penetration during pulling.
 28. It is recommended to use pulling head when the cable is pulled inside pipes or conduits as slipping of stocking might occur inside the pipe or conduit.
 29. While pulling, continuous monitoring of the tensile force should be maintained.
 30. At the bend, cable shall be guided by rollers. Direct touch with trench wall shall be completely avoided.
 31. Immediately after cutting, the cable ends must be suitably sealed so that there is no ingress of moisture.
 32. It is recommended to inspect the cable after laying to ensure that the cable has not been damaged.
 33. Cable after laying should not be straightened but left with slight meandering to allow longitudinal expansion and contraction during thermal cycling.
 34. When the ground water table is high it is advisable to use special cable construction with longitudinal and radial watertight characteristics.
 35. It is very important that any damage to the oversheath should be repaired before backfilling is commenced. Strict attention to detail is necessary in making such repairs and only the approved materials specified should be used. Depending upon circumstances, heat shrinkable sleeves, may be used.

B. CONSIDERATION FOR CABLE CURRENT RATING

When laying cables special attention should be given to:

1. Cable spacing.
2. Any other cable passing by, in parallel or crossing as this might affect considerably

- the cable rating.
3. Any other heat source which might be near the cable as this shall have the same effect as point no. 2.
 4. Drying effect of soil on the value of soil thermal resistivity and side effects on current rating.
 5. Avoid connecting the armor and sheath at both ends for single core cables as this shall reduce the current rating of the cables considerably but special attentions should be given to induced voltage in both normal operation and short circuit.
 6. Avoid pulling single core cable inside steel pipe or any other magnetic material as this shall cause high losses and cable overheating.
 7. Soil thermal resistivity of the actual ground at different places of the trench shall be measured to ensure that the value is matching the one used for current rating computation.

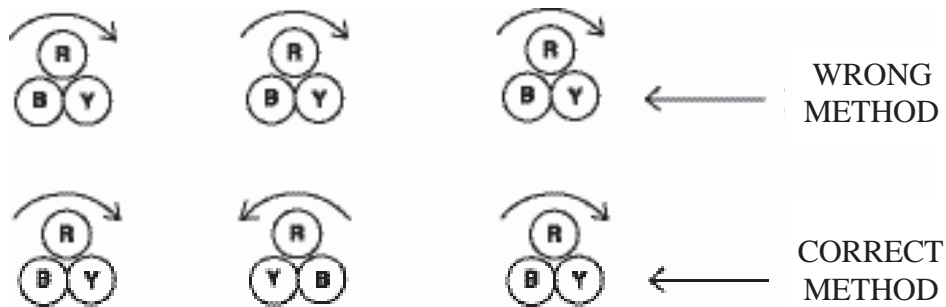
C. SPECIAL PRECAUTIONS FOR LSFH SHEATHED CABLE

Cables with LSFH sheaths require careful handling during installation. Although special additives are used in the LSFH compound formulation to provide the typical flame-retardant characteristics of halogen-free polymers (e.g., high oxygen index, very low smoke density, no acid gas release, and inhibition of flame spread), some of its mechanical properties differ from those of PVC. The following basic installation methods apply.

1. Cables should not be exposed to sunlight for extended periods before installation; the cable sheath temperature should be below 40°C.
2. Installation should be carried out in the morning when the ambient temperature is low.
3. Wires should not be used directly on the cable sheath for pulling.
4. When pulling on uneven surfaces, special care should be taken on very rough terrain.
5. Rollers and bends should not have sharp edges that could damage the sheath.
6. Special accessories compatible with LSFH are recommended for installations requiring enhanced flame-retardant performance.

D. ELECTRICAL CHARACTERISTICS OF SINGLE CORE CABLES

1. Single Core Cables In Parallel.



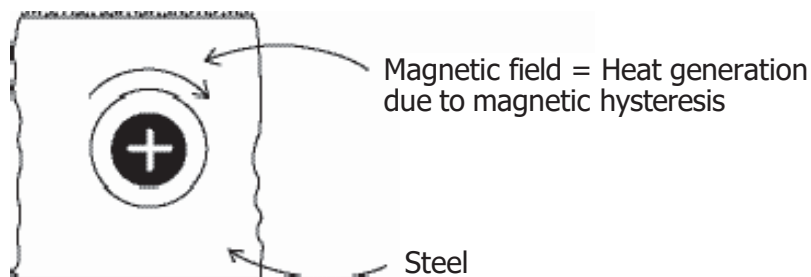
Note: Precise load sharing is difficult with three conductors per phase, and the configuration shown represents the most practical compromise.

2. Armoured Single Core Cables

- If bonded at both ends, the armour carries a circulating current.
- If not bonded at both ends, the unearthed end of the armour has an induced voltage.
- In AC systems, single core cables must have non-ferrous armour.

3. Heating Effect on Single Core (AC) Cable when Surrounded by Steel

- Use - non-ferrous material



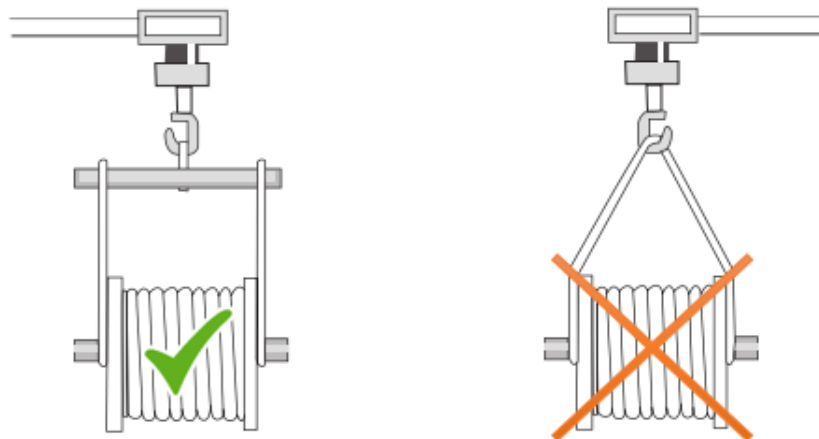
Ex : aluminium or other permissible non-metallic sheet

- Do not pass single core cable through steel conduit.

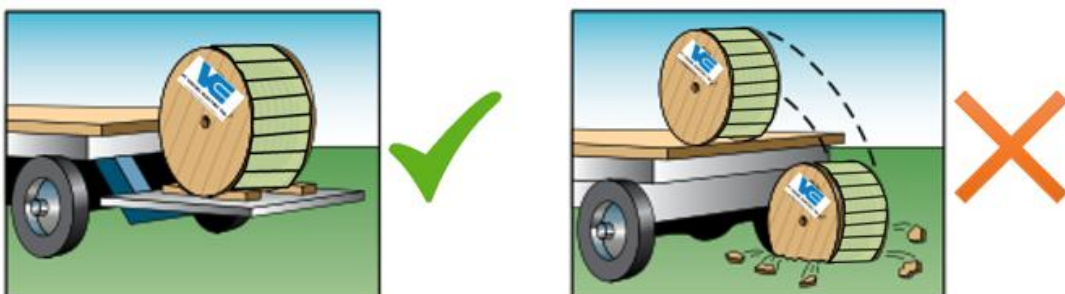
E. HANDLING OF CABLE FROM VEHICLES

- Damage to cables can occur due to the incorrect handling to which the drums and cables may be subjected, causing breakdown of the drum flanges and in exceptional cases, movement of the drum barrel takes place. Once this breakdown of the drum occurs, the cable is immediately exposed to damage.

2. For guidance on handling, please refer to the sketches and notes contained in this booklet, which should be followed closely. We have no objection to the use of fork-lift trucks providing that care is exercised not to damage, or remove, the protective battens when pushing the 'forks' under the drum flanges. Unloading can also be safely accomplished by means of ramps and winches.



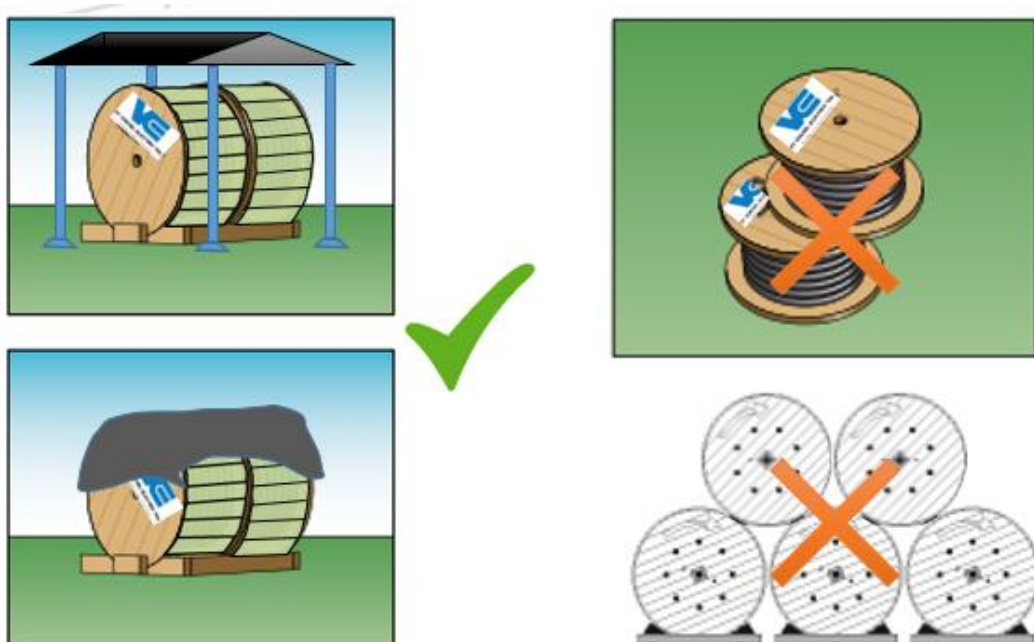
3. Under no circumstances should a drum be rolled off a vehicle on to a 'cushion' of sand, tarpaulin, etc. This action could crumple the flanges and barrel of the drum, driving splinters and nails into the cable.



F. CABLE STORAGE

If any time the drums of cable are required to be stored for reasonably long periods, e.g. prior to shipment or installation, the following points should be noted.

1. The site for storage of drums should be well drained, hard packed soil, or preferably a concrete surface, which will not allow the drums to sink and so give rise to damage due to the extreme difficulty in moving drums when they are sunk into the ground.
2. All drums should be stored with the battens intact, and in such a manner as to leave sufficient space between them for air circulation. Check and tighten tie bolts on the drums at regular intervals.
3. Tier stacking of drums is not recommended. In no circumstances must the drums be stored on the flat with flanges horizontal.
4. All drums, during installation (when the battens have been removed), should be scotched so that there is no danger of the flanges of drums coming into accidental contact with unprotected cable on other drums. The cables should not be left unprotected.
5. Cables should be protected from direct rays of the sun by leaving the battens on or covering the cables with thick black polythene sheet.
6. **IMPORTANT:** Cable ends must be sealed with end cups during storage and transportation.



G. REPAIR TO PVC OUTERSHEATH

During cable drum unpacking, rewinding or laying, damage to the oversheath may accidentally occur. If the cable underneath appears to be in good condition, repair to localised damage at site may be carried out as suggested in the following alternative methods. The objective is that there is no possibility of moisture ingress through damage to the armour or other parts of the cable when it is in its final installed position.

It is very important that any damage to the oversheath observed after installation should be repaired before backfilling is commenced. Strict attention to detail is necessary in making such repairs and only the approved materials specified should be used. Only a brief outline for PVC sheath repair is given below and in case of doubt, the cable manufacturer's advice should be sought. Some of the methods quoted are only suitable for use after installation has been completed, when the cable will not be subjected to significant movement in service.

1. Superficial damage, holes in PVC outersheath

The local area of damage is rubbed down with sand paper. After cleaning with thinner, PVC self-adhesive tape of 25 mm width is applied under tension with 50% overlap. The taping is continued up the chamfer until the top is reached.

2. Repairs with HEAT-SHRINK Sleeves

Heat Shrink sleeves can be conveniently used to repair the damaged oversheath of cables. Where possible, a full unshrunk sleeve is slipped along the cable up to the point of sheath damage but if the cable ends are inaccessible, a zipped sleeve is used.

Depending upon the nature of damage the location cleaned is applied sleeve to cover the opening of the sheath. The heat-shrinkable sleeve is then centrally placed over the point of damage and uniformly heated all round with a gas flame or hot air as recommended by the sleeve supplier. It is important to apply heat evenly and adequately to ensure a water-tight grip.

***For repair of special sheath such as LSFH contact Customer Service.**

TABLE 1 – Installation Bending Radius for Low Voltage Cables

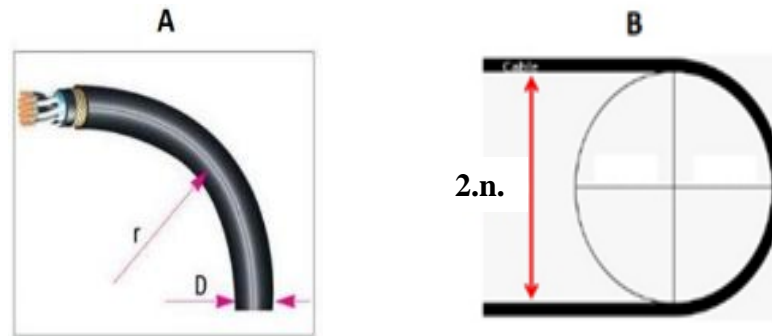
Type of Cable	Multiplying Factor	
	Installation Bending Radius	
	During Installation	Fixed Installation
Single core (Un-armoured,Armoured)	12 D	8 D
Multi-core Sector Shaped Conductor (Un-armoured andArmoured)		
Multi-core Circular Conductor (Un-armoured and Armoured)		
Multi-core (Steel TapeArmoured)	15 D	8 D

Note, D : Overall Outer Diameter Complete Cable

TABLE 2 – Installation Bending Radius for Medium Voltage Cables

Cable Outermost Sheath or Covering	Factor to be Multiplied by Overall Diameter of Cable	
	Installation Bending Radius	
	During Installation	Fixed Installation
PVC	15 D	10 D
HDPE and SHF1 (LSZH)	20 D	15 D
Lead Sheated (Un-Armoured)	18 D	12 D
Lead Sheathed Armoured	15 D	10 D

Note, D : Overall Outer Diameter Complete Cable



Picture 3. Bending Radius

TABLE 3 – Internal Diameter of Duct

Cable Diameter (mm)	Internal Diameter of Duct (mm)
Up to 65	100
65 - 90	115 - 135
90 - 150	200 - 225

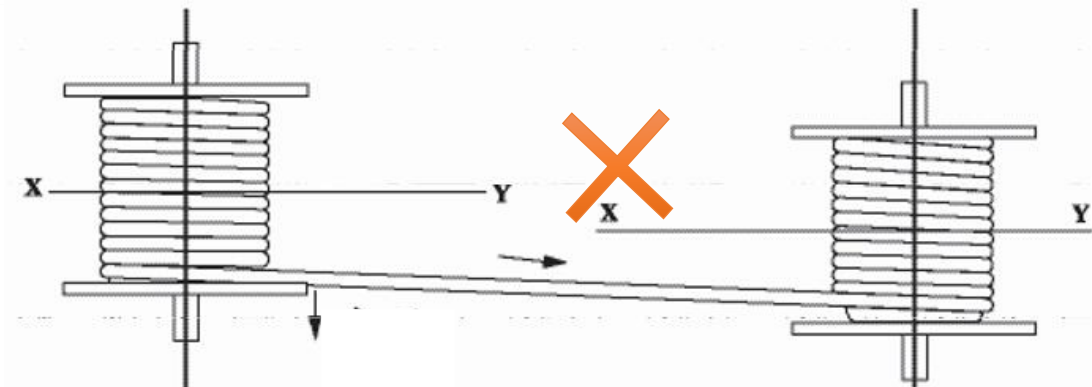
TABLE 4 – Permissible Maximum Pulling Tension

Pulling Tool	Material of Conductor	Permissible Maximum Pulling Tension (Kg)
Pulling eye	Aluminium	$4 \text{ kg/mm}^2 \times n \times A$
	Copper	$7 \text{ kg/mm}^2 \times n \times A$
	Steel	$10 \text{ kg/mm}^2 \times n \times A$
Cable grip	Copper and Aluminium	The same as using the pulling eye, but the maximum tension should be less than two tons.

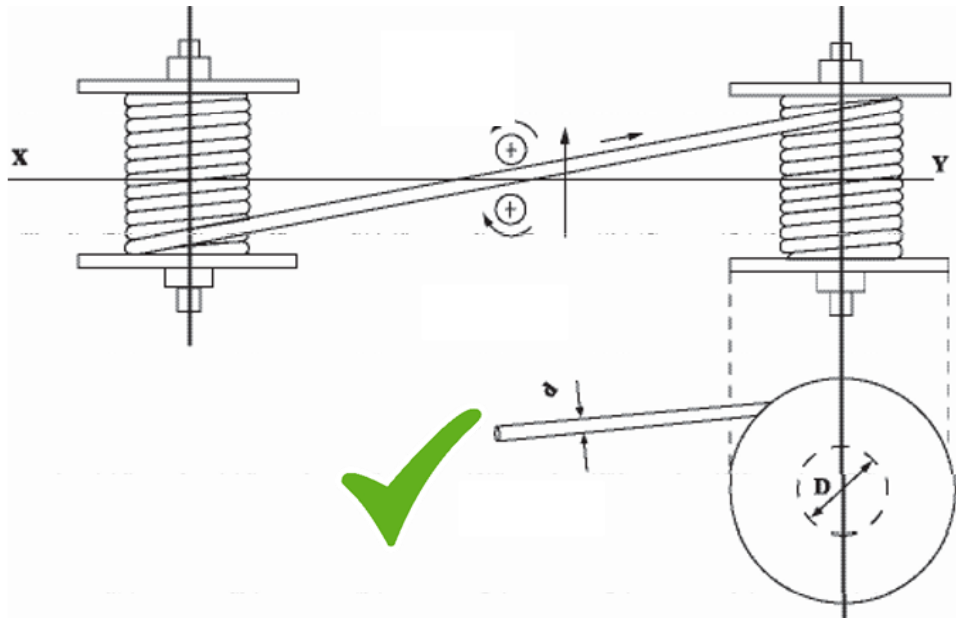
Note, n : Number of core

A : Cross-sectional area of conductor

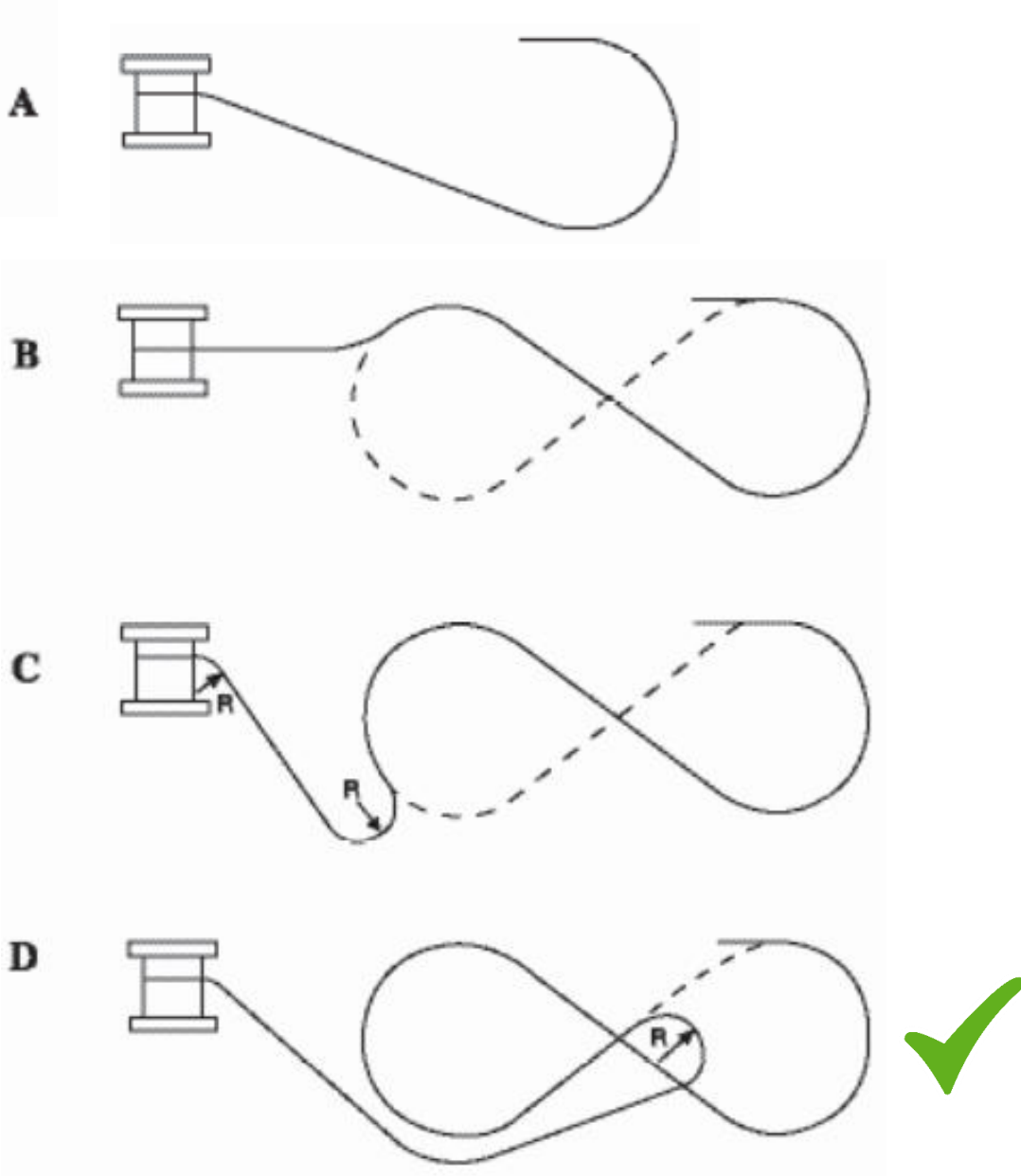
INSTALLATION METHOD



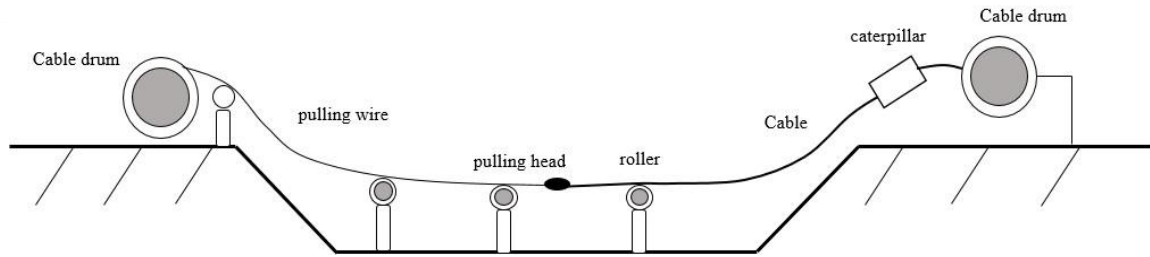
- I) **ALIGN DRUMS BEFORE CABLE REWINDING**
- II) **USE STOPPERS TO PREVENT DRUM LATERAL MOVEMENT**
- III) **USE FREE ROTATING ROLLER GUIDES**



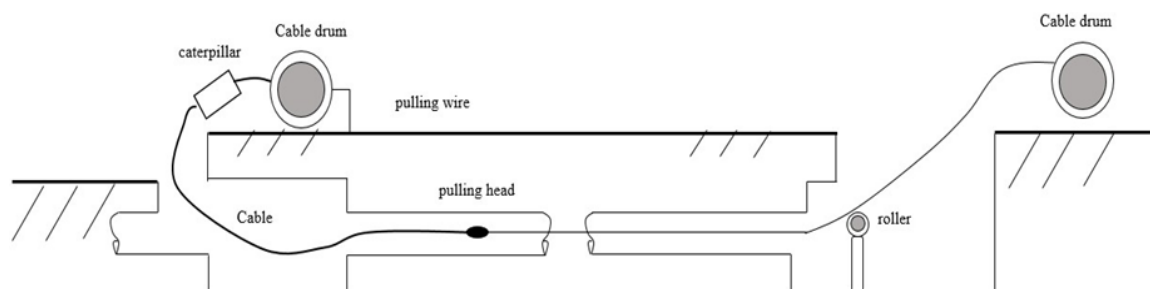
ON THE GROUND CABLE CAN BE FLAKED IN A FIGURE OF EIGHT FORMATION



Direct Burial



Cable Laying at Duct



Cable Laying at Tunnel

