Installation Pulling Tensions & Side Wall Pressure - Limitation of loads to be applied to cables during installation

The Prysmian Group are not experts in the field of cable installation for LV and MV cables. This is not an area that we as a company have practical experience, although the Prysmian Group do have an installation department for high voltage cable systems (above 33kV). The advice that follows is based on guidance that we have compiled from industry documentation.

The Power Distribution suite of cable standards, BS7870 has a specific Annex (A) in BS7870-1 which provides general recommendations for the selection and use of cables, providing useful guidance on cable installation. Each subsection, for example BS7870-4.10, also has its own specific Annex A which provides more explicit information for that cable type. Guidance for other cable standards, such as BS6622, BS5467 etc. can be found in the relevant Annex of those standards.

Maximum pulling tensions and installation minimum bending radii are given in our published data sheets for our medium voltage products. The tensile limit of 5kg/mm² and 3kg/mm² for copper and aluminium respectively, are based loosely on the yield strength of these materials. The maximum pulling tension should therefore not exceed these rules. Historically we have advised a limit of 2 tonnes even on larger sizes of conductor as other issues such as side wall pressures come into play. These figures are also the historical advice given by **BCA, The British Cables Association.**

Conductor Pull

Where the connection is made to the conductor by an Engineered End Fitting (Crimped, Compression, Welded or similar) to form a pulling eye to attach a rope or hawser then: -

1. Maximum **5 kg/mm²** of section of copper conductor up to a total **maximum of 2 tonnes**.
2. Maximum **3 kg/mm²** of section of aluminium conductor up to a total **maximum of 2 tonnes**.

Stocking Pull

Where the connection is made using an 'extending wire stocking', applied over the outside of the cable with the rope or hawser attached to the stocking eye then: -

The above rules for **conductor pull** shall apply provided the stocking can be shown to apply the load without stretching the extruded layers. In practical terms this can be achieved by fitting a correctly sized stocking of the correct diameter and which extends over sufficient cable length (normally 750-1000mm) to prevent relative movement between the extruded layers and the conductor at the pulling end. **Note:** that the use of stockings may require an increased allowance for end scrap.

Notes:

1. It is advised that stockings are used only by experienced installers with access to an extensive range.

2. For complex installations involving many bends it is highly recommended that cables are pulled from the conductors.

Armour pull

Where the load is applied to the wire armour of an armoured cable by forming an integral eye out of the armour then**: -**

Maximum **15kg/mm²** of cross-section of armour up to a total maximum of 2 tonnes.

Where a cable pull is carried out using the armour, it is important to verify that the side wall pressure does not exceed that which would occur when using the maximum pull on the conductor, in conjunction with the minimum installation bend radius.

If the calculated load by this method exceeds the 'conductor pull' method then the minimum bend radii of installation should be increased to limit the side wall pressures. For example, if the armour pull for a cable exceeds the conductor pull by 50%, then the minimum bend radius shall also be increased by 50%.

Side Wall Pressure

The limiting side wall pressure can be calculated from the following formula:

Side Wall Pressure = cable pulling tension (kgf) divided by the installation bending radius (mm)

NOTE: It is advisable to keep cable bends as large as practicable to minimise the side wall pressure

Triplexed Single Core Cables

Where the connection is made to all the conductors using an Engineered End Fitting (Crimped, Compression, Welded or similar) or alternatively by 3 separate 'extending wire stockings', applied over the outside of each cable and combining at one pulling eye position then: -

1. Maximum **5 kg/mm²** of section of copper conductor up to a total maximum of **6 tonnes**.
2. Maximum **3 kg/mm²** of section of aluminium conductor up to a total maximum of **6 tonnes**

Example Triplexed 400mm² Cu cables

Total Applicable Cross-Section = 1200mm² x 5kg/mm² = 6000kg (6tonnes)

Calculation of the Cable Pulling Load

Cable pulling lengths are dictated by the maximum cable pulling tension; sidewall bearing pressure constraints; the complexity of the cable pulls and the method adopted for the cable pull. As a general guideline, for simple nose /end pulling of cables, longer lengths can be pulled if the cable route is essentially straight. If the route is more tortuous, having bends and undulation variations, then a shorter length can be pulled.

The amount of force required to pull a cable during installation approximates to the formula below.

Cable Pulling Force = cable weight for given length (m) x coefficient of friction

A coefficient of friction value of 0.2 is considered to be realistic and on the safe side.

Example: a **500mm² Copper** cable needs to be pulled over a total route length of **600m**. The cable weighs **7kg/m**. The cable route length weight therefore equates to **4.2tonnes** (600 x 7 = 4200kg)

Applying the coefficient of friction value of 0.2, then the force required to pull the cable would be:

= 4200 x 0.2 = 840kg

The maximum pulling tension for the 500mm² copper conductor is 2000kg, so the above pulling force of 840kg would be comfortably within this limit.

NOTE: The above calculation assumes a straight cable pull run.

It should be noted that the coefficient of friction value could be lower if conditions are more favourable and controlled.

Some practical advice would be as follows: -

- Lubricate ducts
- Pull down hill
- Use of rollers
- Maintain bending radius as large as practical
- Pull from the direction which takes any bends first.
- Use powered pay-off stands.

Lubricant

We are unable to recommend 'current' suitable lubricants, but aware that 'Tech Lube HD' has been used by other installers in the past.

Pulling Chambers

We are unable to recommend or comment as to where any pulling chamber should be located/positioned.