Prysmian Group

Linking the Future

Overblowing Of Mini-Cables Into A Reduced Diameter Sub-duct

Ralph Sutehall

Martin Davies

Lee Spicer

Prysmian Group

ralph.sutehall@prysmiangroup.com +44 797 4325714

martin.davies@prysmiangroup.com +44 797 1129603

lee.spicer @prysmiangroup.com +44 2380 608768

Chris Kelly

KN Group

chris.kelly@knns.ie +44 787 6345084

Abstract

Using compressed air to install fibre cables is a well proven technique. The development of new small diameter cables has opened up the possibility of overblowing these cables into a small sub-duct which already contains an active optical fibre cable. This paper will focus on the development of the cable and installation practices that proved that this was a very cost-effective option.

- Fibre Cable Design
  - Material
  - Diameter
  - Stiffness
  - Weight
- Sub-duct Design
  - Material
  - Fill Factor
- Installation Equipment
  - Y Connector
- Installation Practice
  - Lubrication
  - Speed
  - Push Force
- Installations
  - Examples
  - Cost Benefits.

Keywords: Optical fibre unit: Blown fibre, Installation.

1. Introduction

In the late 1990's our customer developed their a cable system which involved installing a 13mm optical fibre cable into a 20mm bore sub-duct, this resulted in a system which had a fill factor of 42%. To date the customer has installed in excess of 100,000 kms of this system. With the development of mini-cables overblowing became an commercially attractive option for larger sub-duct, 26 and 32mm bore and considerable success was achieved. In Europe this involved overblowing a mini-duct into the sub-duct and then installing a mini-cable into the mini-duct.

KN Group moved this development on and developed equipment and processes for installing a cable into these large bore sub-ducts without the need for mini-ducts. The elimination of the requirement to install a mini-duct prior to the installation of the mini-cable resulted in a decrease in installation time which further increased the commercial benefits. They have, for their customer, installed in excess of 1 million metres of mini-cable directly into these larger sub-ducts without the use of a mini-duct.

Rule of the thumb guidelines suggested that the overblown duct/cable will require 2mm radial clearance between the in-situ duct/cable and the sub-duct bore. With the introduction of 200µm G.657 A2 fibre a range of even smaller diameter optical fibre cables became an option for this installation process to be developed further for smaller diameter sub-ducts.

This paper details the development of the cable range and installation practices that made the overblowing of these reduced diameter cables, directly into the 20mm bore sub-duct possible.

Commercially available software modelling suggested that it would only be possible to overblow a distance of approximately 100m with the proposed system.

2. Cable Design

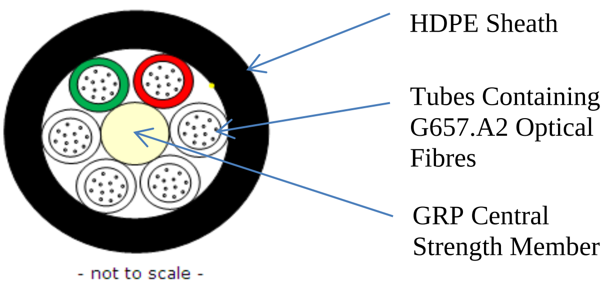

Figure 1. Cable Design 1

Figure 1 shows the final design of the cable that was used for the overblowing trials. It was decided to base the cable design around a 6 around 1 design in order to keep the overall diameter as small as possible whilst maintaining a uniform circular cross-section.
The use of 200µm G.657.A2 fibre was considered as crucial in the cable construction in order to keep the tubes containing the optical fibres at a minimum, 1.3mm diameter, and thus keeping the cable diameter at a minimum. Due to the small diameter of the cable the potential for damage caused by incorrect handling during the installation process e.g. cable fleeting is increased therefore the use of G.657.A2 fibre reduced the risk level. The use of G657.A2 fibre also enables the usage of the 1625nm wavelength as well as temperature ranges down to -40° C. In addition, G657.A2 fibre continues to perform at these requirements after artificial polymer ageing. In conjunction with the robust macro and microbend performance of G657.A2 fibre this ensures a solution that meets the growing requirement for system capability at the 1625nm wavelength.
It was reasoned that the use of a conventional multi-loose tube design would give the optimal installation performance due to it having a neutral bend performance.

Table 1. Key Cable Parameters

Diameter	5.0mm
Weight	22.1 kg/km
Stiffness	38.6Nm2x 10-3

3. Sub-duct Design.

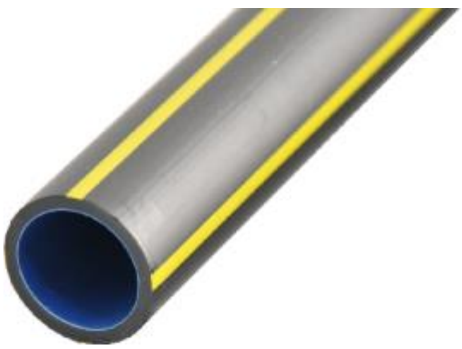

Figure 2. Sub-duct Design

The high density polyethylene sub-duct that the customer installed is shown above. The key parameters are detailed in table 2.

Table 2 . Key Sub-duct Parameters

Overall Diameter	25mm
Inner Diameter	20mm
Bore Configuration	Smooth with low friction liner
Minimum Bend Diameter	1000mm
Crush Resistance	2.4kPA
Fill Factor With 12.9mm Diameter Cable	41.6%
Fill Factor With 12.9mm & 5mm Diameter Cable	47.9%

Figure 3. Cables In Sub-duct.

4. Installation Equipment

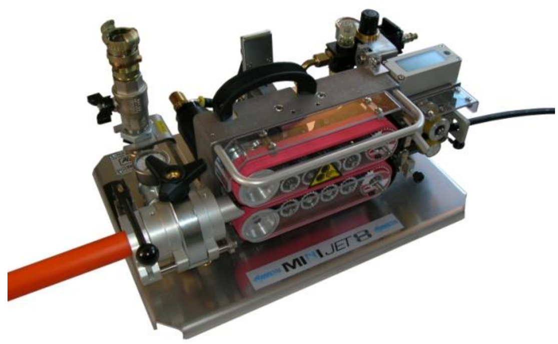

Figure 4. Cable Blowing Machine

The cable blowing machine must be suitable for this new design of mini-cables and should have the ability to limit the level of push force that is applied to the cable so that in the event of the cable hitting an obstruction no damage would be inflicted on the cable. 'Crash Tests' were undertaken to determine the maximum push force that could be applied to the cable. The level achieved during this test was lower than that achieved when undertaken in 8mm bore mini-duct, this is due to the amount of space in the sub-duct for the cable to buckle and get deformed.

Figure 5. Compressor

The output from the compressor must be sufficient to fill the sub-duct with compressed air at a minimum of 12 bar. This results in an airflow of typically be at least 2000l/min. The compressor should have an after-cooler in it in order to ensure that hot air is not blown into the route, thus affecting the cable installation performance.

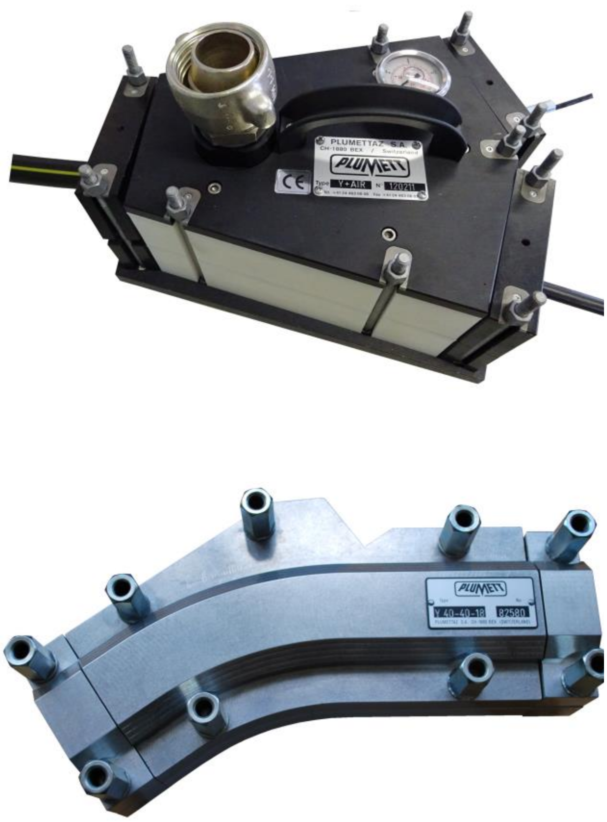

Figure 6. Typical Overblowing Heads

In order to maximize the push force that can be applied to the mini-cable it is important that the link between the cable blowing machine and the overblowing head is a short section of mini-duct, typically 8 or 10mm bore. In view of this the design of the overblowing head had to incorporate the ability to inject the compressed air into the sub-duct at this point rather than at the cable blowing machine as is the normal practice. If the air is injected into the route via the blowing head the level of compressed air being would be reduced due to the constraints of the mini-duct.

5. Initial Installation Trials

Initial installation trials were conducted at the Prysmian Group test track in the UK. It soon became apparent that whilst there was sufficient airflow through the route other factors were influencing the ability to overblow the cable. In any blown system the coefficient of friction between the sub-duct bore and cable sheath is one of the most important factor that influences the installation performance of the cable [1]. With conventional blown systems the cable being installed is in total contact with a low friction material however with this system the cable being installed is in partial contact with a cable with a high density polyethylene sheath. This cable sheath has a higher coefficient of friction than the low friction liner thus the coefficient of friction of the ‘system’ is higher. It was therefore decided to lubricate the cable within the sub-duct. Initial trials using compressed air to blow lubricant with a sponge through the route proved impossible. The sponge would get ‘hung up’ between the cable and sub-duct on the inside of the bends. It was then decided to undertake a trial where the lubricant is poured into the sub-duct and the action of the compressed air would blow the lubricant through the route. This immediately showed positive results.

As the result of the ‘Crash Test’ the installation speed was kept to below 40m/min which ensured that the cable would not be damaged in the event of it hitting an obstruction in the sub-duct or getting wedged between the in-situ cable and the sub-duct.

Normal installation practice is to fit a cable cap onto the leading end of the cable to prevent wedging etc. however it was found that this did not improve the installation performance and in fact reduce it. This is due to the lack of free space within the sub-duct.

Installation trials showed that it was possible to install approximately 300m in a test rack configured as recommended by IEC [2]. However, due to the complexity of the route confidence was high that longer distances were achievable.

6. Installation Practice

The installation practice involves cutting a section out of the sub-duct containing the cable. A suitable wet lubricant is poured into the sub-duct and a mini-duct is then used to connect the cable blowing machine to the overblowing head. The overblowing head is then assembled around the sub-duct. Compressed air is then applied to the overblowing head and the mini-cable installation commences. As stated previously this is not a high speed installation, typically 40m/min, but due to the cost savings achieved it is not important to attempt to reduce the overall time of the installation by increasing the speed of installation.

Figure 7. Overblowing Head Management

7. Installation Examples

From the results at the Prysmian Group installation test site it was decided that any live trial installations would be initially cautiously limited in the distance that was being attempted in order to maximize the chance of success.

7.1 A.40 Road Crossing

The first trial was conducted at a road crossing under a major dual-carriageway between Monmouth and Ross-On-Wye in the Wales/England border region. The key factors for this installation were that conventional installation practices would have involved major traffic management and subsequent disruption and civils costs.
Upon arrival on-site the entire installation, approximately 100m, took less than one hour and was completed without any issues and minimal disruption. The only traffic management that was required was for one lane in the roadway to be coned off in order to provide a safe working area. It can be assumed that the cost savings to the customer were in the order of £50k.

Figure 8. A.40 Road Crossing

7.2 Quedgley Bridge Crossing

This installation involved installing a cable over a bridge, over a major road, for a new housing development. The issues with this installation were once again traffic management and disruption and civils problems associated with working on bridges.
Once again upon arrival on-site the entire installation, approximately 100m, took less than one hour and was completed without any issues. As can be seen from figure 9 the third party disruption was minimal and only for a limited time. It can be assumed that the cost savings to the customer were in the order of £35k.

Figure 9. Bridge Crossing

7.3 Stoke Lacey Installation

This installation involved overblowing a cable in a sub-ducted route alongside a minor road. The total length was approximately 550m. In view of this it was decided to attempt a centre-blow involving 250m and 300m installations. This route included a 1 in 10 climb up a hill.

Figure 10. Route Configuration

Figure 11. Cable Fleeting For Centre Blowing

Upon arrival on-site the entire installation took less than three hours and was completed without any issues. Once again the disruption to third parties was kept to a minimum. It can be assumed that the cost savings to the customer were in the order of £25k.

8. Range Extending

Recent live installations have shown that distances of 800m in a single blow are achievable. This means that it can be assumed that 2kms per day is a realistic target when using centre-blowing and other range extending practices. This could also involve cascade blowing using two or more installation sets. Cascade blowing could increase the daily rate even more.

9. Connectivity

Once installed it is important to protect the mini-cable from damage in man-holes, particularly when the centre-blowing installation process has been used. In order to achieve this a new closure has been developed which accommodates all the sub-duct sizes that the customer uses and allows up to two overblown cables to be dropped off into an alternative optical fibre joint. This closure is designed to be suitable for retro-fit and is rated to IP68. As with all blown system joints a pressure relief valve is fitted for safety to protect against over pressurisation.

Figure 11. Overblow Closure

10. Conclusion

It has been shown that overblowing of a 72 fibre mini-cable into a 20mm bore sub-duct is achievable and that the cost savings, overall speed of installation and minimum third party disruption are impressive.

11. Acknowledgments

The authors recognise the valuable assistance of colleagues within the Prysmian Group and KN Group. A special mention should go to Greg Walsh and Graham Brown of KN Group for their patience and experience which has gone a long way to ensuring the success of this development.

12. References

[1] R. Sutehall, M. Davies “Installation of Mini-Cables: Factors that Influence the Installation Performance of Mini-cables” IWCS 2010.

[2] IEC 60794-1-2 Ed. 3.0 (draft) Method E24 (86A/1340/CD)

13. Authors

Ralph Sutehall is a Principal Engineer with the Communications Division of Prysmian Group in the UK, where he is responsible for installation & applications development. He has been working with optical fibre cables for 44 years and has numerous patents and conference papers in this field of study.

Martin Davies is Chief Engineer (Telecoms) with Prysmian Group in the UK, where he is responsible for product design and development. He has been an active member of a number of standardisation bodies, including BSI, ETSI and IEC, from whom he received the IEC 1906 award, and is a Fellow of the Institute of Engineering and Technology.

Lee Spicer is an Engineer within the UK Telecoms Business of Prysmian Group. He is responsible for the management of projects including the design and development of new blown mini cables. He has worked for Prysmian Group for 10 years, holds a BSc in Manufacturing and Mechanical Engineering and is currently completing his Master's Degree in Business Administration.

Chris Kelly is a Project Manager for KN Group based in the UK responsible for the Overblow Project. He has been working in the installation industry for 9 years. To date he has installed over one million meters of Prysmian cable in the UK using the overblow method.