Experiences in Sweden with Preferrulized Cables Blown to Homes through 4/3 mm Microducts

W. Griffioen[1], W. Greven[1], T. Pothof[1], F. de Bruijn[1], P. Lock[1], I. Koren[2], D. Colot[2], V. Coggi[2], T. Ahl[3], M. Eriksson[3], K. Gustavsson[3]

[1] Draka Comteq Cable Solutions, Gouda, Netherlands
Tel: +31 182592490, Fax: +31 182592290, E-mail: willem.griffioen@draka.com

[2] Diamond, Losone, Switzerland
Tel: +41 917854545, Fax: +41 917854502, E-mail: d.colot@diamond-fo.com

[3] Rala, Skänninge, Sweden
Tel: +46 14283888, Fax: +46 14242675, E-mail: tobias.ahl@rala.se

An expensive part of installation of FTTH networks is connectorization of the cables. A preconnectorization solution is presented in this paper with preferrulized cables blown from a central point through 4/3 mm microducts to different homes. At the moment of finishing the home connection the rest of the connector is easily snapped on. The first experiences with this solution from a pilot project in Aneby, Sweden, will be discussed.

1. Introduction

An expensive part of installation of FTTH networks is connectorization of the cables, especially at the side of the houses. Preconnectorization is a possible solution, but this has also drawbacks. Below some examples of current solutions are given:

- Installation of complete cabletrees with preconnectorized connections [1]. Used at a large scale in the USA. Drawback: difficult to plan and install.
- Blowing of preconnectorized cables in microducts from the homes [2]. Drawback: blowing from individual homes is labour intensive and is inconvenient for the customers.
- Premounted connector with fibre stub. Inside the connector the fibre stub can be spliced, by fusion [3] or mechanically. Drawback: still relatively difficult labour at homes.

As a solution to above mentioned drawbacks preferrulized cables are blown from a central point through microducts to the different homes, stopping automatically when reaching the home termination. At the moment that a home connection is finished the rest of the connector is easily snapped on. Tests with a prototype of the pre-ferrulized (LC) cable were first done in Delfzijl, The Netherlands. Here blowing into a 4/3 mm microduct was possible over a length of 1000 m. Recently the first phase of a pilot project in Aneby, Sweden, was performed, connecting the first 61 homes. The preferrulized cables were installed from different small spools and boxes. After evaluation it was concluded to continue with the smallest spools for the rest of the project. Here also BendBright-XS [4] fibres will be used.

2. Preferrulized Cables

As a solution to above mentioned drawbacks preferrulized cables (cables with prefabricated semi-finished connectors, see Fig.1) are blown from a central point through 4/3 mm microducts to the different homes. This reduces labour costs significantly. The cable stops automatically (because of an air-venting end-stop) when the termination points in the homes are reached. There is no need to enter the homes at this part of the installation, a significant advantage. At the moment that a home connection is finished the rest of the connector is easily snapped on. Summarising the advantages:

- Versatility of a microduct system [5].
- No need to plan (branches, cable lengths) in advance.
- Low costs for blowing (or pushing).
- Low costs for mounting home connector.
- Wall box or frame for splicing connector to cable can be eliminated (or reduced in size when integrated with electronics).
- Homes need only be entered once.
- No inconvenience for the customers.

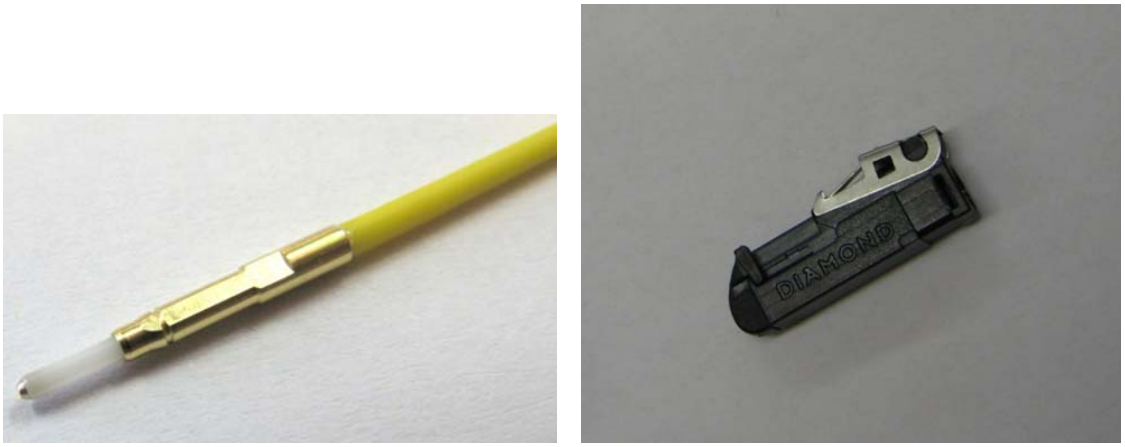

Figure 1: Preferrulized cable (left) and snap-on housing (right).

3. Prototype

The tested prototype of the pre-ferrulized 1.8 mm cable transforms to a cable with terminated LC-connector when finished, i.e. uses a 1.25 mm ferrule, see Fig. 1. The connector benefits from the active core alignment technique which optimizes the connections' optical performance by positioning the fibre core at the exact centre of the ferrule [6].

4. Tests in Delfzijl, The Netherlands

Tests were first done in Delfzijl. Blowing, see Fig. 2, was possible with 10 bar in a 4/3 mm microduct in a standard IEC trajectory [7] of 1000 m long and 180° bends with bend radius of 160 mm every 100 m and a Y-branching duct-connector close to the termination box, see Fig. 3, without loosing performance compared to the situation without ferrule.

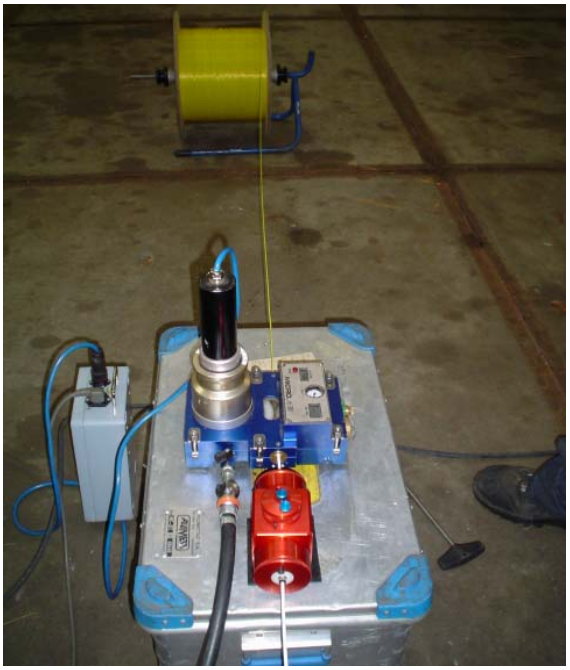

Figure 2: Blowing the preferrulized cable into a 4/3 mm microduct.

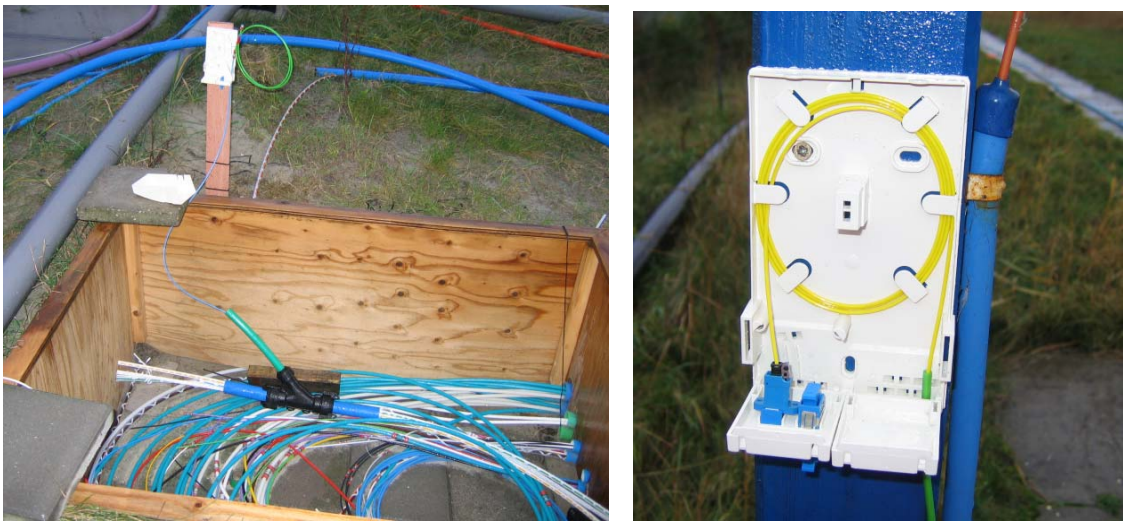

Figure 3: End of the IEC trajectory with Y-connector and termination box (left), latter close-up (right).

At the end of the trajectory a piece of microduct of defined length, with air-venting and end-stop, was placed and the cable came to a full stop automatically when the pre-ferrulized cable reached the end-stop. The defined length was chosen such that the finished connectorized cable matches the length needed in (or to) the termination box. Inserting the pre-ferrulized cable in the connector housing was done using a special toolset, without any problems.

Installation tests were also done with a pushing machine mounted on a battery-powered drilling machine, without the use of air. Here the preferrulized cable was installed from a box (see further in this paper). When using the proper lubrication a length of 40 m could be installed, with several bends in the trajectory. This length is enough for installation within a single home, but not enough to reach all homes in a typical house-block situation as in the pilot described below.

5. Pilot in Aneby, Sweden

Currently a pilot project with the preferrulized cables is running in Aneby, Sweden, a small community (population around 2000) in Småland, a province blessed with forests and lakes. In the first phase of the project 61 homes (the total of the pilot is around 400), located in blocks of about 10 homes each, see e.g. Fig. 4, were connected. Installation was done from a room in the cellar to all the houses in a block, and sometimes also to another block. The prefabricated lengths selected for the pilot were 50 m, 75 m and 130 m.

Figure 4: One of the blocks of houses of the Aneby pilot.

5.1 Spool or box?

Installation of the pre-ferrulized cables from different small spools and boxes was tried. In the latter case the cable is stored in loops with torsion, freed again during

pay-off. The loops coming out of the box, see Fig. 5, needed guiding by hand. The cable suffered too much from memory after being stored in the box for a long time (this was not the case with the cables tested in Delfzijl, which were made with a different cable jacket material). The boxes could still be installed, but will be abandoned for the rest of the pilot. Experiences with big and small spools, the latter see Fig. 6, were positive. The small spools will be used for the rest of the pilot.

Figure 5: Blowing from a box.

Figure 6: Blowing from a small spool.

5.2 Small bends

Blowing through most bends in the microducting attached to the wall was possible, e.g. the ones shown in Fig. 7 left. The existing wall boxes, however, see e.g. Fig. 7 right, could not always be passed. The smallest bend radius seen was 30 mm. The preferrulized cable has been developed for a minimum bend radius of 80 mm (this will be much smaller for 5 mm microducts!). During the first cables blown the microducts were opened temporary at the wall box locations. The rest of the cables were blown with the microducts extended and hanging out of the wall boxes during installation. After the cables passed the microducts the loops were placed back inside the wall boxes again.

Figure 7: Bends in the microducting. Left the bundles of 4 mm microducts, 12 of them in black flexducts mounted on the walls, and right an existing wall box with lack of space.

5.3 Mounting of the connector

When the preferrulized cable is blown until the end of the piece of microduct of defined length (with air-venting and end-stop), placed at the home termination, this piece is removed. Next the cable boot and a metal cylinder are sleeved over the ferrule. Then the metal cylinder is crimped around the ferrule and the cable jacket using a crimp tool, see Fig. 8 left, for extra strength. Now the ferrule is pushed into the connector housing, the latter being placed in a special holder, see Fig. 8 right. Finally the cable boot is pushed over the metal cylinder. In Fig. 9 the finished connector is shown.

Figure 8: Crimping cylinder on ferrule (left). Pushing ferrule into connector housing (right)

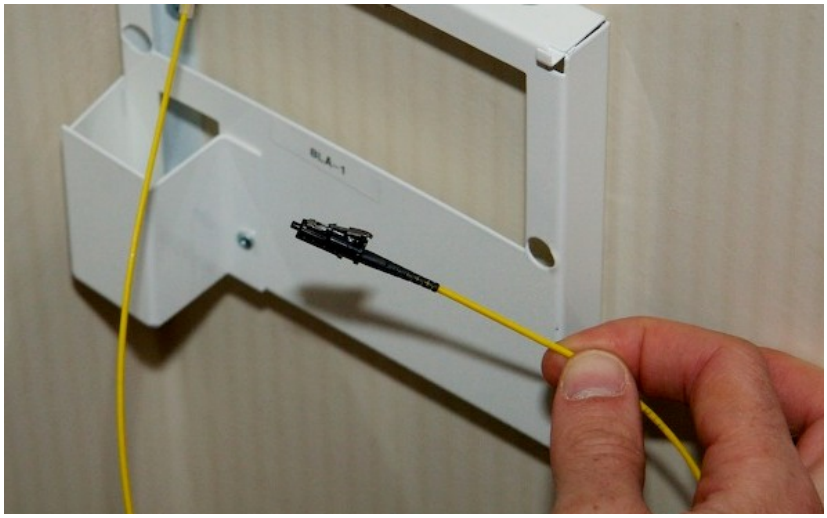

Figure 9: Finished connector.

In Fig. 9 also the frame is shown on which the electronics will be placed. Inside the frame, which was formerly used to store the spliced pigtail with SC-connector, there is place for patching from the LC-connector to an SC-connector. In the future electronics with LC-sockets will be used and the whole frame is not needed anymore.

5.4 Time to install

The first part of the pilot (cable installation) started on Monday, May 7th at 9:30 am. First some instruction was given to mount the connector. At 5:15 pm the cables were blown to 19 homes of which 5 were finished with the connector (the ”connector

man" was needed on another project during the afternoon and returned the other day, late afternoon). After the learning curve of Monday the remaining 42 cables were blown in on Tuesday. The connectors were finished on Wednesday 9:00 am.

6. Conclusion

Preferrulized cables have shown to be an economic solution for installing FttH networks. Difficult labour at the customer's homes is eliminated, as well as an extra house visit. Blowing of the preferrulized cables through narrow 4/3 mm microducts is possible over more than 1000 m. In Aneby, Sweden, a pilot (400 homes) is running of which the first phase (61 homes) was completed in 2 days, the cable blowing including finishing the connector. Installing from small spools and boxes was evaluated, resulting in a choice for the smallest spools. Existing wall boxes, where a smallest bend radius of 30 mm was found for the microducts, could not always be passed. This was solved by extending the microducts there and hang them out of the boxes temporarely.

Acknowledgements

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