Fast-forward the world connecting: Advanced fiber deployment technology

i. Background

According to ITU Connect 2020 agenda, 90% of the rural population worldwide should be covered by broadband services and 55% of households should have access to the Internet by 2020.

Ultra-HD video, Smart Home, Industry 4.0, IoT and all the other front technologies and applications that are going to form an intelligent and convenient lifestyle and workplace need to be supported by a strong, high quality and wide-covered network.

It's an ambitious goal for all the counties but also a long and difficult way to go, especially for the network construction. A huge number of fibers need to be deployed to form the strong network but there are different obstacles to achieve the fast growth: high cost for access, low efficiency, low quality of performance etc.

Therefore, new advanced fiber deployment technology is urgently needed to achieve a fast-forward world connecting.

ii. Technology Introduction

A typical fiber deployment project includes engineering, global planning, customer acquisition, civil works and cable installation, of which civil works account for 35~65% of the total CAPEX.

The key factor to speed up the fiber deployment worldwide is to achieve a civil work solution with high efficiency, high cost-effective and high quality.

◆ Conventional Methodology

Civil works of underground fiber deployment are mainly combined by 3 phases in sequence: open trench (trenching), cable/duct laying, backfilling. In most of the cases nowadays, classical excavators or manpower are used to implement this job. This conventional methodology has the following drawbacks:

- **Low efficiency.** A fleet of excavators are required on the jobsite to get a decent output per day. Many machines means more chances of breakdown, more diesel consumption, and more operators, all of which lead to a complicate jobsite organization. Besides, excavator is not able to make micro-trench or mini-trench, which is the most optimized solution for fiber installation.

- **Low quality.** Due to the limitation of excavator’s bucket action, trench bed is likely not to be well flatten (“wave shape ”). This bring the difficulty to lay down the cables or ducts and create potential deformation risk on a time base. It will also lead to a difficulty to blow the fiber in the duct on a long distance without manhole.

- **Not versatile.** Excavator is not able to open trench on all kinds of ground condition. Rocky grounds will require additional hydraulic breakers to open the trench.
- **Not environment friendly.** Low efficiency leads to more pollution emission. The noise, vibration and dust generated during the work, especially with hydraulic breakers, will seriously disturb the residents, pedestrians and public transportation in urban area.

- **Dissociation of the trenching and laying process.** This leads to several problems: risk of trench self-backfilling/collapsing before network is installed, risk of damage to the network which is manipulated with unappropriated means.

- **Dissociation of the trenching and backfilling process.** Trenches left open can lead to accident with the external environment (ie pedestrians) and on the site itself.

- **Specific drawbacks of excavator traditional methods in urban areas:**
  - High inertia jobsite organization. Jobsite requires heavy equipment and many manpower. Difficult to move in an urban environment.
  - Excavator means wide trench which involves deep trench which means risk of crossing existing utilities.
  - Heavy equipment is not maneuverable enough to steer clear of street furniture and other obstacles. For example footpath trenching is almost impossible.

All of the above mentioned points may lead to a fail to obtain the Right of Way (RoW) from the authorizations.

◆ **Advanced integrated solution for fiber deployment**

Thanks to its leading know-how of fiber installation and its full range of advanced trencher equipment, Tesmec Group is able to offer integrated solutions for underground fiber deployment for all kinds of applications and ground conditions:

- **Applications:** FTTH, City Rings, Intercity Line, Backbone Network
- **Ground conditions:** asphalt/concrete pavement, rock/soil road, rock/soil off-road

**WORKING CONCEPTS & TECHNOLOGY ADVANTAGES:**

a) **Ground Penetrating Radar (GPR) survey**

Surveys carried on with GPR technology are very important before civil works due to the higher amount of buried infrastructures and the uncertain of their exact position. Mini and micro trenching procedures are characterized by the use of a cutting tool engaging the ground. In such a way that the operator cannot be warned in time.
if there are areas along the path of the cut already occupied by pipes or cables, which consequently risk to be damaged. It is essential that underground surveys are carried out beforehand to verify whether or not there are utilities already in place. Any object present in the subsoil generate characteristic hyperbolic shapes in the radar images: these hyperbolic shapes are due to the rebounds of the radio frequency signals transmitted by a GPR. Analyzing these shapes, the operator can have a brighter idea of the depth of the utilities and perform the excavation in a safer environment. GPR surveys can be performed at the end of a civil work in order to map the final position of the utilities installed.

b) Micro and Mini trench Concept

A **micro-trench** is created by cutting a channel to a nominal width no greater than 5 cm, and to a nominal depth of between 35 cm and no more than 50 cm, while a **mini-trench** is created by cutting a channel to a nominal width greater than 5 cm but no greater than 20 cm, and to a nominal depth of between 35 cm and no more than 50 cm.

The use of micro and mini trenching technology is especially suitable in urban or suburban locations, on asphalted surfaces such as carriageways and footways for laying pipes and cables both longitudinally and transversely in relation to the road bed. In particular, mini trench is also suitable for unmetalled roads and/or verges.
Where practical requirements dictate that the trench is to be cleaned at the same time of trenching operations, a dust extraction machine, of capacity compatible with the scale of the projected excavation, for removal of the spoil. The extraction unit can be coupled to the trenching machine by way of suitable ducts, or built into the machine, so as to collect and eliminate the spoil directly from the point of excavation;

Narrow-mini-trenches shall be backfilled with a cement mortar of fluid consistency, containing high strength cementitious binders, selected aggregates and special additives, which is poured into place. The setting properties of the mortar shall be such that a vehicular carriageway can be returned to normal use in very short time.

Mini and Micro trench phases

1. **EXCAVATION**
2. **CLEANING THE TRENCH**
   The cleaning of the trench can be done adopting two different methods:
   a) Simultaneously with excavation;
   b) Following excavation.
3. **LAYING THE INFRASTRUCTURE**
   The infrastructure or underground utilities can be laid adopting two different methods:
   a) Simultaneously with excavation;
   b) Following excavation.
4. **BACKFILL**
5. **MARKING AND/OR MAPPING THE TRENCH**
6. **REINSTATEMENT**
7. **CONNECTION TO ACCESS CHAMBERS**
c) Mini Worksite Concept:
   Equipment number, manpower need, quantity of removed and backfilling materials, size of the trench and manholes have all been minimized.
   Optimized trench size (micro-trench/mini-trench that cut only what need to be cut), high efficiency performance and limited dust & noise also minimize the disturbances for the residents, pedestrians and users of streets.

d) Single Shift Concept:
   In one single working shift the 3 phases will be done (trenching + cable/duct laying + backfilling). Therefore when the work ends there is almost no trace of the ongoing work. (No trench left open, no duct left unearthed etc.)

e) Linear Work Process:
   Easier to organize the site. In line process: 1) Trenching → 2) Removal of extracted materials → 3) Duct laying → 4) Backfilling → 5) Asphalt reinstatement (if necessary).

f) Versatile trenching machines:
   Thanks to the special designing dedicated for fiber deployment, Tesmec trencher equipment can trench different materials (concrete, asphalt, interlocking blocks) on different locations (carriage way, foot path, trench close to the footpath curb, motorway, off-road). Tesmec trencher equipment are compact enough to transit directly on the footway itself, or if operating on the carriageway.
g) High quality of work:
Trench with regular shape and stable wall that is easy for cable/duct laying.
Clean and flat trench bottom: Easy for blowing fiber on very long distances → Minimization of manholes/connections → gain of time and cost saving, no signal loss etc.

Mechanized laying: Duct is carried and laid by the machine: no hazardous manipulation of the drums and potential perforation of the duct / damage to the fiber.

All these advantages lead to a high efficiency, high cost-effective and high quality implementation of the civil works for fiber deployment. And it will make the obtaining of the RoW much easier.
Successful Projects
Case A: FTTH (Dusseldorf)

The jobsite was set up in Wegberg (Germany); the trenching total length was approximately of 291 m (this is the trench length).

After the pavement was ready for trenching operations, the SideCut finished the trench in less than half a day.

Three fiber optics conduits has been deployed into the trench; one with 7 fiber optics connections for houses connections and two with 4 fiber connections each one for cabin-to-cabin connections.

The specification of the project were very strictly:

1. No traffic interruption;
2. The trench could follow non straight paths and trench dimension were: 120 mm width and 450 mm depth;
3. The trench could be done in very narrow spaces;
4. Very few bricks of the pavement had to be removed before trenching;
5. High speed trenching.

The mentioned advantages were achieved with the use of SideCut machine and high safety levels were guaranteed:

1. No traffic interruption (see blue circle in following figures).
2. The trench could have non straight paths and the trench dimensions were: 120 mm width and 450 mm depth (see green circle in following figures).
3. The trench could be done in very narrow spaces (see grey circle in following figures).
4. Very few bricks of the pavement had to be removed before trenching (see orange circle in following figures).
5. High speed trenching (about 75-80 m/h).
Case B: Intercity

The jobsite was set up in Rovereto (Italy); the project total length was approximately of 15 km. Six PN 10 Ø 40 mm fiber optics conduits has been deployed into the trench.

The main specifications of the project were:
1. Minimum traffic interruption;
2. The trench could follow non straight paths and cross the road;
3. The trench could be done in different kind of soils (on carriage way and also close to the footpath curb and off-road);
4. High speed trenching (the road was the only one connecting Rovereto with south-east villages).

The mentioned advantages were achieved with the use of a 300 Trencher machine and high safety levels were guaranteed:
1. Minimum traffic interruption (except when crossing the road, the traffic can proceed on one carriageways).
2. The trench could follow non straight paths and cross the road (see green circle in following figures).
3. The trench could be done in different kind of soils (see blue circle in following figures).
4. High speed trenching (the machine was adopting the automatic deployment system in order to save time and increase the safety of the operations).