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SERIES L: CONSTRUCTION, INSTALLATION AND PROTECTION OF CABLES AND OTHER ELEMENTS OF OUTSIDE PLANT

Low impact trenching technique for FTTx networks

Recommendation ITU-T L.83

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Summary

With the miniaturization of the telecommunication infrastructure, i.e., with mini-ducts and mini-cables, it has been possible to use a low impact trenching technique to carry out all the steps of the network construction in one single day, in a less invasive way in terms of time and space, and with a smaller construction site than for the previous trenching technologies. Recommendation ITU-T L.83 describes this trenching technique, which allows the easy installation, in narrow trenches, of underground optical cables and mini-cables in ducts or mini-ducts or directly buried. This type of narrow trench allows the use of reduced dimension machinery in small sized roads, typically those in cities, producing a lower quantity of waste material and so should be used in urban areas. This technology is mainly characterized by the simultaneous work of a suction machine and a trench saw, which allows for the possibility of opening and closing the work site the same day.

History

Edition	Recommendation	Approval	Study Group
1.0	ITU-T L.83	2010-07-29	15

Keywords

Environmental low-impact, FTTx network, reduction, urban trenching technique.

FOREWORD

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1 Scope

This Recommendation:

- gives advice on general requirements of the main phases in which the work can be divided;
- gives advice on the methods and procedures for performing the work;
- gives some application criteria;
- describes situations where a low impact urban trenching technique is recommended.

2 References

The following ITU-T Recommendations and other references contain provisions which, through reference in this text, constitute provisions of this Recommendation. At the time of publication, the editions indicated were valid. All Recommendations and other references are subject to revision; users of this Recommendation are therefore encouraged to investigate the possibility of applying the most recent edition of the Recommendations and other references listed below. A list of the currently valid ITU-T Recommendations is regularly published. The reference to a document within this Recommendation does not give it, as a stand-alone document, the status of a Recommendation.

[ITU-T L.39] Recommendation ITU-T L.39 (2000), *Investigation of the soil before using trenchless techniques.*

[ITU-T L.48] Recommendation ITU-T L.48 (2003), *Mini-trench installation technique.*

[ITU-T L.84] Recommendation ITU-T L.84 (2010), *Fast mapping of underground networks*.

3 Definitions

3.1 Terms defined in this Recommendation

This Recommendation defines the following term:

3.1.1 urban trenching technique: It is characterized by a width of maximum 5 cm and typically a depth of maximum 30 cm.

4 Abbreviations and acronyms

This Recommendation uses the following abbreviations and acronyms:

FTTx Fiber To The x, where 'x' stands for the final location on the end-user side

GPR3D Ground Penetration Radar 3 Dimensions

NGN Next Generation Network

5 Conventions

None.

6 The urban trenching cable-laying technique

The urban trenching technique should be applied especially in urban areas, where car traffic and shop presence is very high and on routes that generally involve asphalted surfaces such as roads and sidewalks with a base of compact material (asphalt or concrete).

It is not recommended that the technique be used on routes where the soil subgrade is sandy, gravelly or contains medium-sized cobbles (i.e., measuring 10 to 20 cm in diameter).

The main advantages of this technique over traditional cable-laying technologies are the very small obstruction of the road and the low impact on traffic condition due to the road yard cleaning, the immediate removal of debris and the quickness of opening and closing of the road yard.

The urban trenching technique is normally carried out by simultaneously cutting through the paving and digging a trench whose depth and cross-section vary in accordance with the number of ducts to be laid: depth is ≤ 30 cm, while cross-section can be ≤ 5 cm. In order to guarantee a protection against impact resulting from road-repairing, the depth of the laid infrastructure should be maintained constant at a known level that should be 5 cm deeper than the foreseen asphalt cutting depth normally specified for road surface repair works. Figure 1 shows some possible duct and mini-duct installation configurations that can be used.

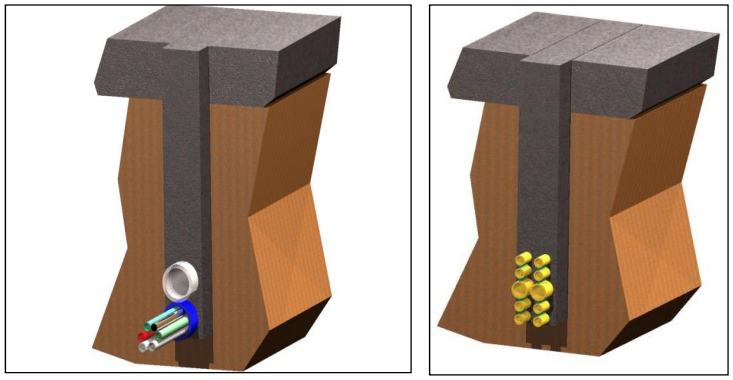

Figure 1 – Examples of urban-trenching duct installation configuration

Any crossings through unpaved sections (which should in any case have a compact subgrade) should be carried out using the same technique.

6.1 Preparatory step

Generally, a detailed survey of the route should be carried out, the purpose of which is to identify the work required to be done before starting cable installation operations. Such work could include, for instance, the preparation at bridges, or at road or rail crossings. Further, it is necessary to determine closure locations and section ends.

The location of all underground utilities should be determined in order to establish the correct route for the trench. This is normally accomplished by means of cartographic documentation provided by the administrations that own the road or by the utility company, and/or through instrumented field surveys. The detailed utilities investigation should be made with the GPR3D fast solution technique [ITU-T L.84].

The designed route should be free from sharp changes in direction. Where such changes are unavoidable, they should be made by means of cuts angled so as to comply with the minimum bend radii specified for the ducts and cables.

Where necessary, the contractor can take core samples along the planned route to determine the type of subsoil or as a further method of checking for obstacles. A GPR3D fast solution should be used in order to detect ground characteristics [ITU-T L.84].

6.2 Excavation requirements

The following requirements should be observed in cutting while applying the urban trenching technique:

- comply with all provisions and regulations established by the administrations involved as regards excavation permits, schedules, etc;
- place the barriers and road signs required by current legislation, regulations and the administrations involved, in clearly visible locations around the excavation site.

Generally, the site is opened and closed during the same day, so the excavation should not remain open during the night.

6.3 Working phases for laying the infrastructure or cables

All the construction activities should be split in separate operational steps involving subsequent phases (Figure 2). This synergism should allow:

- flexible use of smaller machines;
- reductions of time and space occupancy.

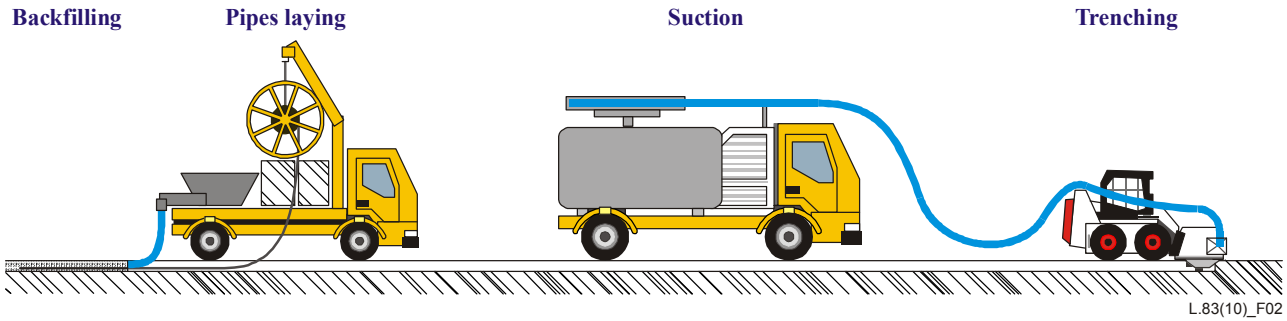

Figure 2 – Daily reduced trenching technique logical scheme

6.3.1 Simultaneous trenching dig phase and cleaning phase

It is recommended that the urban trenching technique be characterized by the simultaneous work of the trench saw and the suction machine. This combined action should allow the waste material to be collected while produced by the saw, leaving the site clean immediately after the end of the trenching phase and completely removing dust problems.

6.3.1.1 Trenching dig phase

The urban trench should be made using a small size saw disk, mounted on small dimension operating machines. The trenching cut should not damage the urban road pavement near the dig section. The saw should be inside a protective carter connected via a flexible tube to a vacuum pump installed on the suction machine.

6.3.1.2 Spoil suction phase

The debris suction and the digging phase should be performed simultaneously in order to accelerate the trench cleaning action.

Spoil should be transported to authorized disposal sites in accordance with current local laws. The trench cleaning shall be made with automated methods in order to avoid or limit troubles to people and environmental pollution.

At the end of this phase, the trench cross-section should be completely free of stones and the bottom of the trench should be clean. The trench and the near zones should be completely clean of debris that could reduce the backfilling material features.

6.3.2 Ducts or cable laying

The reel can be mounted aboard a machine subsequent to the saw, so that the duct(s) or cable can be automatically fed into the trench, via a suitably shaped guide integrated into the ploughshare, as the excavation proceeds.

The equipment and procedures used for this purpose should guarantee that:

- initial duct or cable configuration and position in the urban trenching technique are maintained along the entire route unless special circumstances dictate otherwise;
- if obstacles or situations are encountered which make it impossible to proceed with the urban trenching technique, the reel (and thus the ducts or the cable) can be removed from the machine without having to cut the ducts, thus ensuring that cable deployment can be continued using conventional methods without performing splices that are unnecessary from the technical standpoint.

6.3.3 Backfilling phase

After the ducts, mini-ducts or cables are installed, the trench should be backfilled with a highly resistant and fast-hardening material. The trench backfilling shall be made with rapid cement mortar casting. The mortar should be quick setting, with fluid consistency, containing cement with high strength, selected aggregate and special additives. Bitumen material shall be avoided. The backfilling material should have particular features in order to assure vehicle traffic restoration within two to four hours and it shall present high compatibility with mechanical and visual characteristics of existing pavement surface.

6.3.3.1 Mortar features

The cement mortar should have the following features:

- high compressive strength (> 50 N/mm^2), better than jet concrete (30 N/mm^2) and similar to precast concrete, in order to protect the infrastructure below;
- slip resistance similar to that of asphalt (60) – EN 1340;
- it should undergo controlled shrinkage in order to adhere to trench walls in a good way ("silos" effect);
- intrinsic fluidity of the material in order to fill completely the trench;
- high resistance to thermal variation, above all to frost and thaw cycles;
- easily removable, in case of pavement resurfacing, without causing damage to the infrastructure.

6.4 Identification

The urban trenching technique should not need any kind of identification, because the backfilling material laying is just an identification element for the new infrastructure.

6.5 Resurfacing

The urban trenching technique should not need pavement resurfacing. That should be achieved with backfilling material, both on the road and on the sidewalk. At the end of the activity there should not be cracks, steps or smear. The new pavement colour should be similar to the current one.

6.6 Maintenance

The maintenance of buried cables and ducts should be performed with the same techniques and tools as for normally buried infrastructures because the backfilling concrete mortar should be easily removable.

7 Daily urban trenching methods and procedures

The debris suction phase and the cutting phase should be executed at the same time. All phases described in clause 6.3 should be subsequent, but if the environmental conditions, like urban traffic, are very hard, or because of administration prescriptions allowing only limited site lengths, suction/digging phases and pipes laying/backfilling can be made at different times.

8 Daily urban trenching application criteria

Some criteria for specific applications of the urban trenching technique are given in the following clauses.

8.1 Entry to existing manholes or chambers

Connection to an existing prefabricated structure such as a manhole, pit or chamber should be accomplished by means of a conventional excavation approximately 2 m long and dropping gradually from the urban trenching technique to points of access to the prefabricated structure in such a way as to comply with minimum duct or cable bend radii requirements. Ducts and cables should enter the prefabricated structure at a suitable distance (e.g., 20 cm) from the structure's interior floor. Ducts should be secured with cement mortar on both the internal and external sides of the prefabricated structure. Inside the prefabricated structure, individual ducts should be separated and located at a horizontal distance of some centimetres (e.g., 3-4 cm from each other) and they should protrude (e.g., 15-20 cm) inside the prefabricated structure. Once ducts have been terminated in the prefabricated structure, the latter should be surfaced and smoothed.

8.2 Road crossings

New road crossings should be cut using the same methods envisaged for lengthwise excavations. Where existing conventional type road crossings are used (e.g., with ducts located at a depth of approximately 1 m from the road surface), the two different depths should be joined by an excavation which drops gradually for a length of at least 2 m. In case of crossing, any cables should be protected with appropriate ducts along the whole crossing length.

Appendix I

Italian experience regarding "one day" reduced mini trench

(This appendix does not form an integral part of this Recommendation)

The capabilities of realizing new infrastructures with lower environmental impact, and the tendency to use digging technologies less invasive in terms of time and space of road occupation and restoration, have driven network construction technologies towards the miniaturization of primary elements. In Italy, an innovative approach is developed to carry out all steps of the network construction, for FTTx applications, in one single day, with big advantages in terms of environmental and social costs.

In order to overcome all the problems caused by traditional digging technologies, each step of the process has been analysed. Thanks to the simultaneous and synergic use of a trench saw and a suction pump, the digging work can be completed very quickly, with reduced-dimension machinery, and with no residual material to be removed. The last element of this solution is the innovative material used to fill in the trench, with a very fast hardening time to allow to complete the work in a few hours, restoring the pavement to the previous state. This technique allows opening and closing digging works in only one day.

With a global approach, the problem of working downtown is traduced into an effort of reducing whole critical dimensions related to the usual trenching machines, beginning with trench dimensions.

This kind of new trenching technique is characterized by a maximum width of 5 cm and a maximum depth of 30 cm.

The true innovation during the trenching phase is the simultaneous operation of a powerful suction machine and a trench saw, as shown in Figure I.1.

Figure I.1 – Trench saw combined with suction machine

This combined action allows the waste material to be collected as it is produced by the saw, leaving the site clean immediately after the end of the trenching phase and completely removing dust problems. Figure I.2 shows clearly the cleaning of the site and inside the trench.

Figure I.2 – Cleaning of the site and inside the trench

Another important innovation is related to pavement re-establishment. According to traditional techniques, the trench is normally filled with excavated material and binder on top, and finally a layer of pavement is posed. With traditional technologies, pavement can be restored only after the backfilling material is ready and usually it takes at least 24 hours.

With the new Italian trenching system, thanks to an innovative material which has mechanical and esthetical characteristics similar to the pavement, the trench is completely filled in one operation and with just one material. Moreover the fast hardening time, main characteristic of this material, allows the closure of the working site in just a few hours (Figure I.3).

Figure I.3 – Innovative material before and after hardening completed

Thanks to the behaviour of this innovative material, the site can be opened to the traffic just a couple of hours after the filling. Its physical and mechanical characteristics, combined with the esthetical result, avoid laying of the asphalt carpet, reducing operating phases and troubles for citizens.

A new mixing machine adapted to the type of material has been developed (Figure I.4). The mixing machine features, which can be installed on ordinary trucks, several solutions optimal for trench filling while keeping the site clean.

Figure I.4 – The mixing machine

The whole system can thus be divided into two different modules: the first, which will perform the trenching phase, is composed by the saw and the suction machine; the second, which will perform re-establishing phase, is composed by one truck with the mixing machine. These two modules can work in line or at different times/places, allowing major flexibility, but anyway guaranteeing a better solution.

The new Italian reduced trenching technique has introduced a new point of view on trenching techniques, turned into a less invasive way. Thanks to the combined use of innovative instruments and materials, the construction site (of very reduced dimensions) can be opened and closed in one single day of work, thus minimizing the impact for the community. Examples of these new trenching sites, on the road and on the sidewalk, are shown in Figures I.5.a and I.5.b, respectively. In these pictures a site in an urban area of Milan is shown, as well as the advantages of the new digging technique with respect to the traditional one, as discussed above.

Figure I.5 – The new digging technique at a worksite in an urban area of Milan

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