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

Mini-trench installation technique

ITU-T Recommendation L.48

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Summary

This Recommendation describes the so-called mini-trenching technique, that allows the installation in small trenches of underground optical cables in ducts or directly buried copper cables. The advantages of this technique over conventional cable laying technologies lie essentially in its speed of execution, lower cost, significantly lower environmental impact and limited disruption to road traffic and, as a consequence of the previous items, easiness in obtaining permits for the taking over of public area.

Source

ITU-T Recommendation L.48 was prepared by ITU-T Study Group 6 (2001-2004) and approved under the WTSA Resolution 1 procedure on 29 March 2003.

FOREWORD

The International Telecommunication Union (ITU) is the United Nations specialized agency in the field of telecommunications. The ITU Telecommunication Standardization Sector (ITU-T) is a permanent organ of ITU. ITU-T is responsible for studying technical, operating and tariff questions and issuing Recommendations on them with a view to standardizing telecommunications on a worldwide basis.

The World Telecommunication Standardization Assembly (WTSA), which meets every four years, establishes the topics for study by the ITU-T study groups which, in turn, produce Recommendations on these topics.

The approval of ITU-T Recommendations is covered by the procedure laid down in WTSA Resolution 1.

In some areas of information technology which fall within ITU-T's purview, the necessary standards are prepared on a collaborative basis with ISO and IEC.

NOTE

In this Recommendation, the expression "Administration" is used for conciseness to indicate both a telecommunication administration and a recognized operating agency.

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As of the date of approval of this Recommendation, ITU had received notice of intellectual property, protected by patents, which may be required to implement this Recommendation. However, implementors are cautioned that this may not represent the latest information and are therefore strongly urged to consult the TSB patent database.

CONTENTS

ITU-T Recommendation L.48

Mini-trench installation technique

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 works;
- gives some application criteria.

2 The mini-trenching cable-laying technique

The mini-trenching technique can be applied on routes that generally involve asphalted surfaces such as roads and sidewalks with a subgrade of compact material.

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). If other underground utilities crossing a planned route already exists at a depth interfering with the depth of the mini-trench, this technology is not appropriate.

The advantages of this technique over conventional cable laying technologies lie essentially in its speed of execution, lower cost, significantly lower environmental impact and limited disruption to road traffic and, as a consequence of the previous items, the easiness in obtaining permits for the occupation of public area.

Mini-trenching 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 normally between 30 and 40 cm, while cross-section can vary between 7 and 15 cm. In order to guarantee a protection against impact resulting from road-repairing, the depth of the laid infrastructure shall be maintained constant at a known level that must be 5 cm deeper than the foreseen asphalt cutting depth normally specified for road surface repair works.

Figure 1 shows one of the possible installation configurations that can be used. Which configuration is selected will depend on the type of machinery employed and the number of ducts or cables envisaged in the project.

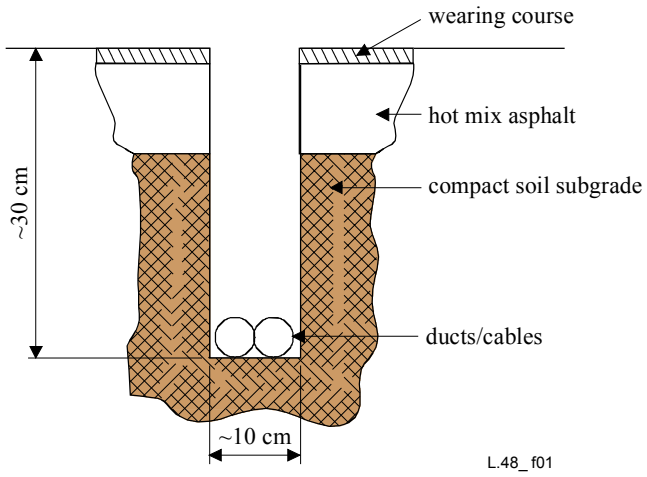

Figure 1/L.48 – Example of mini-trenching installation configuration

In cases where the mini-trench is dug along a road with no curb or sidewalk, the excavation shall normally be located at distance of around one metre from the edge of the road (or if possible just on the external side of the lateral line). In special circumstances where this is not possible, the mini-trench may be dug in the shoulder at the edge of the asphalt.

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

2.1 Preparatory steps

The mini-trench is excavated using appropriate disc-type cutting machines as shown in Figures 2 and 3.

Figure 2/L.48 – Example of standard cutting machine

Figure 3/L.48 – Example of fully automated trenching machine

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

The location of all underground utilities must 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. Where other means of determining the location of underground utilities are not available, ground penetrating radar shall be used at detection depths between 0 and 100 cm.

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.

2.2 Excavation requirements

The following requirements shall be observed in cutting the mini-trench:

– 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.

– If the excavation must remain open or the road will be otherwise obstructed during the night or under low-visibility conditions, road signs shall be complemented by lighting devices of the color, shape and size envisaged by applicable regulations.

2.3 Mini-trench cleaning

The following operations shall be carried out after excavating the mini-trench:

– Remove spoil from the sides of the excavation[1].

– Remove adjacent paving materials which were damaged as a result of excavation.

– Clean the bottom of the trench.

At the end of these activities, the trench cross-section shall be completely clear and the bottom free from stones.

2.4 Laying of the infrastructure or cables

The infrastructure or cables can be installed in two ways:

2.4.1 Simultaneous excavation and ducts or cables laying

Reels can be mounted on board of the cutting machine (see Figure 3) so that the duct or cable can be automatically fed into the trench, via a suitably shaped guide integrated into the ploughshare, as excavation proceeds.

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

– the operations envisaged in 2.3 are carried out.

– initial duct or cable configuration and position in the mini-trench 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 mini-trench, the reel (and thus the ducts or the cable) can be removed from the cutting 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.

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[1] Spoil must be transported to authorized disposal sites in accordance with current legal requirements.

2.4.2 Non-simultaneous excavation and ducts or cables laying

After completing the excavation, ducts or cables are installed using the conventional method and in accordance with the requirements specified in the installation standard. Ducts and cables installed in trenches shall maintain their initial configuration and position in the excavation unless special circumstances dictate otherwise.

2.5 Pull cord and plugs

To prevent extraneous materials such as dust and water from penetrating the ducts, the ends shall be sealed with suitable watertight plugs during all stages of work.

To permit subsequent fiber optic cable installation in each duct in the infrastructure, a pull cord shall be inserted and attached to the end of the plugs.

When performing this operation, care must be taken to ensure that the cord is installed with sufficient slack.

2.6 Backfilling

After the ducts or cables are installed, the mini-trench is backfilled by pouring concrete (e.g., 200 kg/m^3 cement) with suitable foaming additives to ensure that a large amount of air is entrained, thus making the resulting structure mechanically as similar as possible to the soil subgrade surrounding the trench.

Backfill shall satisfy the following performance requirements:

– Volumetric stability.
– Backfill shall adhere to the walls of the excavation and to the infrastructures.
– The entire excavation volume shall be filled.
– There shall be no differential settling.
– Setting times and developed strength shall be such that paving can be reinstated at least 24 hours after backfilling.
– Compressive strength shall be such as to withstand the stresses produced by light and heavy traffic.
– Backfill shall be permeable to gases and liquids.
– Backfill shall be readily removable.
– Backfill shall be highly workable (concrete mix shall be stable, cohesive, and sufficiently fluid to permit the use of pumps).
– Backfill shall be strong enough for vehicle load. No breaking or jumping out of backfill-piece can be permitted from the point of view of safety in traffic.

Special requirements for backfill expressed by the administrations which own the road must be evaluated on a case-by-case basis.

In addition to securing the infrastructure in position at the bottom of the mini-trench, backfilling materials provide ducts and cables with mechanical protection.

In both installation methods indicated in 2.4, infrastructure or cable geometry shall be guaranteed, and suitable measures shall be taken to avoid undesired floating of the ducts or lightweight cables during backfilling operations.

Where ducts are laid by hand, they may be secured to the bottom of the mini-trench by means of weights or retainers located at intervals along the excavation before proceeding with backfilling operations. In such cases, retainers shall be removed upon completion of backfilling.

When backfilling the excavation, the contractor shall use suitable means to keep asphalt paving clean.

While waiting for the road to be resurfaced upon completion of backfilling, the contractor shall take all necessary precautions (use of temporary barriers and warning signs, filling the excavation to street level in special cases such as crossings, etc.) in order to prevent hazardous situations and ensure that safety requirements are satisfied.

2.7 Mechanical protection

2.7.1 Galvanized iron channel

Where interference with other utilities can occur and it is not possible to comply with the spacing requirements envisaged by current regulations, ducts shall be provided with mechanical protection in accordance with applicable standards and regulatory requirements.

Where the infrastructure is installed near trees whose roots could cause damage, it shall be protected by means of U-shaped galvanized steel raceways of suitable dimensions, equipped with covers and embedded in the same type of concrete backfill envisaged for the excavation.

2.8 Identification

To ensure that the infrastructure or cables location is clearly apparent in future excavation operations, and those carried out by other service providers in particular, the following identification shall be provided:

- *Access and transport network*

  Identification shall not be visible from the exterior, and shall be accomplished by adding suitable coloring agents (oxides) to the concrete backfill. Coloring shall be permanent.

- *Transport network*

  In addition to the identification described above, transport network infrastructures shall be provided with identification visible from the exterior, and accomplished using appropriate signs, adhesive label, etc.

2.8.1 Installation criteria for identification

Identification visible from the exterior of the infrastructure or cables shall be installed in accordance with the following criteria:

- Identification shall be provided at all points where route changes direction, and shall be located as close as possible to the infrastructure.
- Along straight sections of route, identification shall be provided at intervals of not more than 300 m.
- Preference should be given to installations adjacent to road intersections.
- Where stakes are used to facilitate identification, they shall be installed perpendicular to the roadbed.

2.9 Resurfacing

It shall be proceeded with resurfacing after at least 24 hours have passed from the time the mini-trench was backfilled. If not otherwise required by the administration that owns the road, resurfacing shall be carried out as follows:

2.9.1 Asphalt cement roadway and sidewalk

The following operations are recommended:

- Apply a thick coat to mini-trench edges and subgrade using hot mix asphalt consisting of 50% bitumen. Alternatively, rubberized cold mix asphalt may be used providing that it ensures equal or better performance than the hot mix technique.
- Close the mini-trench by applying a surface course of hot mix asphalt with fine grade aggregate similar to that used for the existing wearing course.
- Compact the resurfaced paving to road level using a roller.

At the end of the operations described above, there shall be no uneven edges, steps or irregularities along the mini-trench.

The color of the new pavement shall be as close as possible to that of the existing pavement.

2.9.2 Concrete roadway and sidewalk

The mini-trench shall be resurfaced using concrete with properties similar to those of the existing pavement.

2.9.3 Unpaved areas

For lengths of mini-trenches excavated in unpaved areas, the top 10 cm of the excavation cross-section shall be backfilled with spoil from the excavation, if suitable, or with suitable compacted aggregate.

2.10 Maintenance of cable or duct after laying

The maintenance of buried cables and duct shall be performed with the same techniques and tools as for normally buried infrastructures because the backfilling concrete mortar should be easily removed as specified in 2.6.

3 Mini-trenching methods and procedures

The methods for performing the construction works of a mini-trench excavation depend on the contractor organization and know-how, but nevertheless it is possible to consider at least three different methods for performing the job:

– standard;

– partially automated;

– fully automated.

3.1 Manual procedure

The various step of the technique described in clause 2 are performed one by one using the appropriate machines and tools. The precautions and limitations given in clause 2 about the soil subgrade types, fully apply.

3.2 Partially automated procedures

The excavation works and the laying of ducts or cables is performed in a single step as mentioned in 2.4.1. In this case, thanks to the insertion of ducts or cables into the groove done immediately after the excavation through a suitable guide, also a sandy and gravelly soil substrate can be affordable because the putting in place of ducts or cables is done before the loose materials beside the cutting fall down into the trench.

3.3 Fully automated procedures

This case occurs when the backfill operations and the spoil materials collection and cleaning-up is performed together with the cutting of the trench and the laying of ducts or cables.

The use of a single machine for performing a fully automatic operation improves furthermore the advantages of the techniques in terms of speed and less traffic disruption.

In fact this procedure allows a very short and compact yard moving quickly along the trenching path so that the disturbance to residents and to commercial activity is reduced to a minimum.

4 Mini-trenching application criteria

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

4.1 Entry to existing manholes or chambers

Connection to an existing prefabricated structure such as a manhole, pit or chamber shall be accomplished by means of a conventional excavation approximately 2 m long and dropping gradually from the mini-trench 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 shall enter the prefabricated structure at a suitable distance (e.g., 20 cm) from the structure's interior floor.

Ducts shall be secured with cement mortar on both the internal and external sides of the prefabricated structure.

Inside the prefabricated structure, individual ducts shall be separated and located at a horizontal distance of some centimetres (e.g., 3-4 cm from each other) and they shall protrude (e.g., 15-20 cm) inside the prefabricated structure.

Once ducts have been terminated in the prefabricated structure, the latter shall be surfaced and smoothed.

4.2 Road crossings

New road crossings shall 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 shall be joined by an excavation which drops gradually for a length of at least 2 m.

In case of crossing, directly buried copper cables shall be protected with appropriate ducts along the whole crossing length.

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Series D	General tariff principles
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Series F	Non-telephone telecommunication services
Series G	Transmission systems and media, digital systems and networks
Series H	Audiovisual and multimedia systems
Series I	Integrated services digital network
Series J	Cable networks and transmission of television, sound programme and other multimedia signals
Series K	Protection against interference
Series L	**Construction, installation and protection of cables and other elements of outside plant**
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Series S	Telegraph services terminal equipment
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