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Design and Construction of Underground Services Ducts in the Contraction with Streets in the City Centre.

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***ABSTRACT**: Technical infrastructure regeneration by means of installation of utilities in underground services ducts. Description of difficult conditions of urban area for location and construction of driven routes and cut and cover objects. Construction in the environment with concentrated services, buildings and municipal transport. Difficult geological and hydro geological conditions (cohesionless soils).*
***KEYWORDS**: underground services ducts, design and construction, risk factors, environment*

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UNDERGROUND SERVICES DUCTS – UTILITY TUNNELS -
A SOLUTION FOR TECHNICAL INFRASTRUCTURE REGENERATION

The historic, business and culture city centre of Prague, the capital of the Czech Republic, features not only intensive development but also dense traffic and technical infrastructure with prevailing city-wide functions. Most of cable and especially pipe networks are obsolete, prone to failures and their capacity is not adequate for the rising requirements of the city. The major part of networks is in poor technical condition; the pipes (age 80 – 100 years) are in critical condition and their technical life is coming to the end. There are detected frequent uncontrolled water leakages exhibit into the ground. However, even comparatively younger networks a speed reduction of their service lives, due to low quality of used materials and low quality of prior maintenance. In addition to this, all networks are subject to negative effects caused by the soil environment (moisture, corrosion, earth currents, dynamic impact of surface traffic and more).

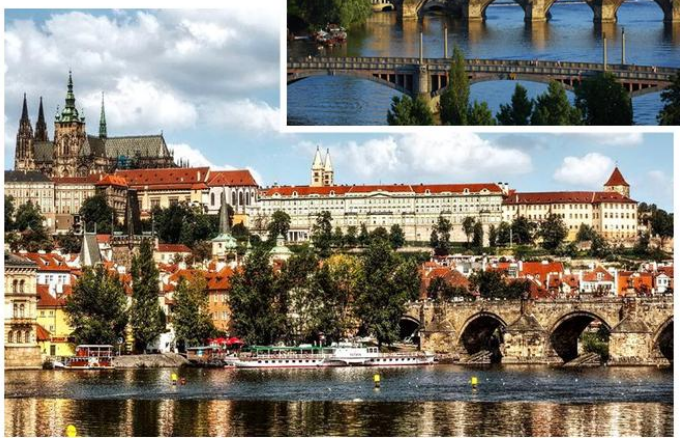
Another issue - apart from problems associated with technical life and condition – is the insufficient capacity of existing networks which dimensions and density no longer complies with increasing requirements associated, among other, with making the city centre more attractive by new construction, modernization of existing housing estate and – last but not least – with new and more intensive utilization. The consequence are ongoing construction works, both scheduled, i.e. extension and modernization of existing utilities and not scheduled (remedy of failures and defects). In addition these works interfere with the municipal life and city traffic, affect the environment and are a big nuisance of inhabitants.

As an alternative of trenching the networks in the soil and associated recurring excavations, the systematic construction of underground services ducts has been made in the centre of Prague since 1985.

At the same time, the underground services ducts provide for increasing the capacity of existing networks thus allowing a wide development of the city centre. Installation of utilities in underground line structures – underground services ducts {„utility tunnels“} – allows to establish an open system of routes on step-by-step basis to cover the territory of the entire city in the future. For the city centre of Prague, establishing two types of underground services ducts with different function and installation height has been found useful.

Prague:

The capital of the Czech Republic, situated on the river Vltava.
The city has a great history (since 1992 in UNESCO).
With the size of 285 km^2 and population of 1.25 mil has a demand for trouble-free services.



Ecology – advantages and benefits of operation

Considering the long-term function, the underground services ducts will reduce negative impact on the environment dramatically. Particularly, the benefits of underground services ducts of the 3rd category can be as follows:

- dramatic reduction of surface excavation works, thus improving the conditions of any follow-up works to be made on utility networks
- easy inspection and maintenance of utilities laid in the ducts without any surface works and traffic (incl. no-collision repair of house service pipes)
- utility networks operation safety provided by inspection measurements and central operation control, increasing technical life of utility networks by limitation of negative impact of the subterranean environment (corrosion, earth currents, dynamic impact of the city traffic and more).
- utility networks operation savings achieved by reduction of losses by more rapid identification of network failures
- increasing transport capacity of individual media by construction of new networks, increasing the dimension or even replacement of the medium

From the short-term perspective, the environment will be affected only by construction of underground services duct routes (made from the surface) and acquisition of land for site preparation. Adverse impact of the construction is considered as necessary allowing to derive long-term benefit from this demanding civil engineering works.

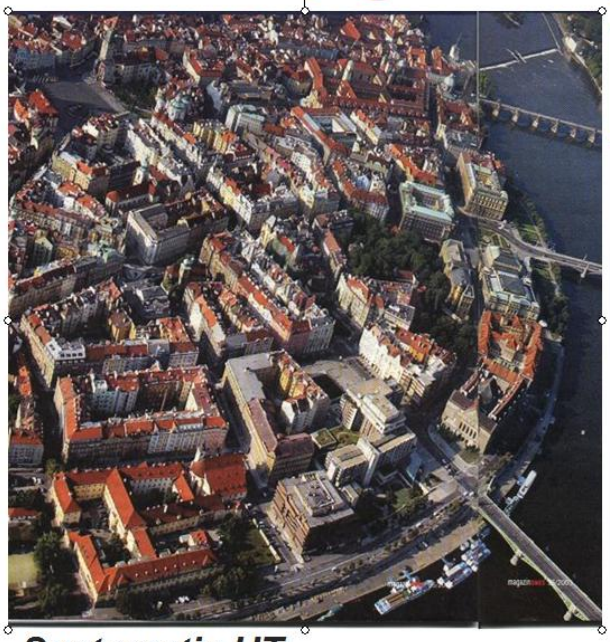
Attitude of the public to the work

Being a line-type work, any underground services duct necessarily has all consequences caused by the contact with the locality and the environment. Nevertheless, there is a qualitative difference between the way how the professionals and the wide public regard this type of works and other civil engineering works in the transport sector, e.g. metro or road tunnels. The efficiency and return of investments in the transport sector is obvious and their contact with the environment is limited on a comparatively small surface (hallways of metro stations, tunnel entry). The amount of investment and the extent of special geotechnical measures related to useful transverse profile of the construction work can be better justified in technical terms.

On the other hand any need of network regeneration (in case of underground services ducts) may not be obvious for nonprofessionals because supply of power, water etc., in most cases, is considered a normal and indispensable component of everyday life. When it come to the construction, its consequences will affect wider surrounding environment more heavily because the construction involves a complex of associated measures: connection of all adjacent buildings, branch chambers in crossing points, affecting adjacent utility networks and more. Projected demanding and specific technical measures, associated with lower cross profiles of ducts,

involve dramatic increase of investment costs, which may adversely influence the approval procedure or postpone the realization of the underground structures. This type of civil engineering work is of benefit for the community and its technical life is long, however, its return of investment is long as well. That means more difficult approving of the projects and more complex development of the area.

Prague's utility tunnels:



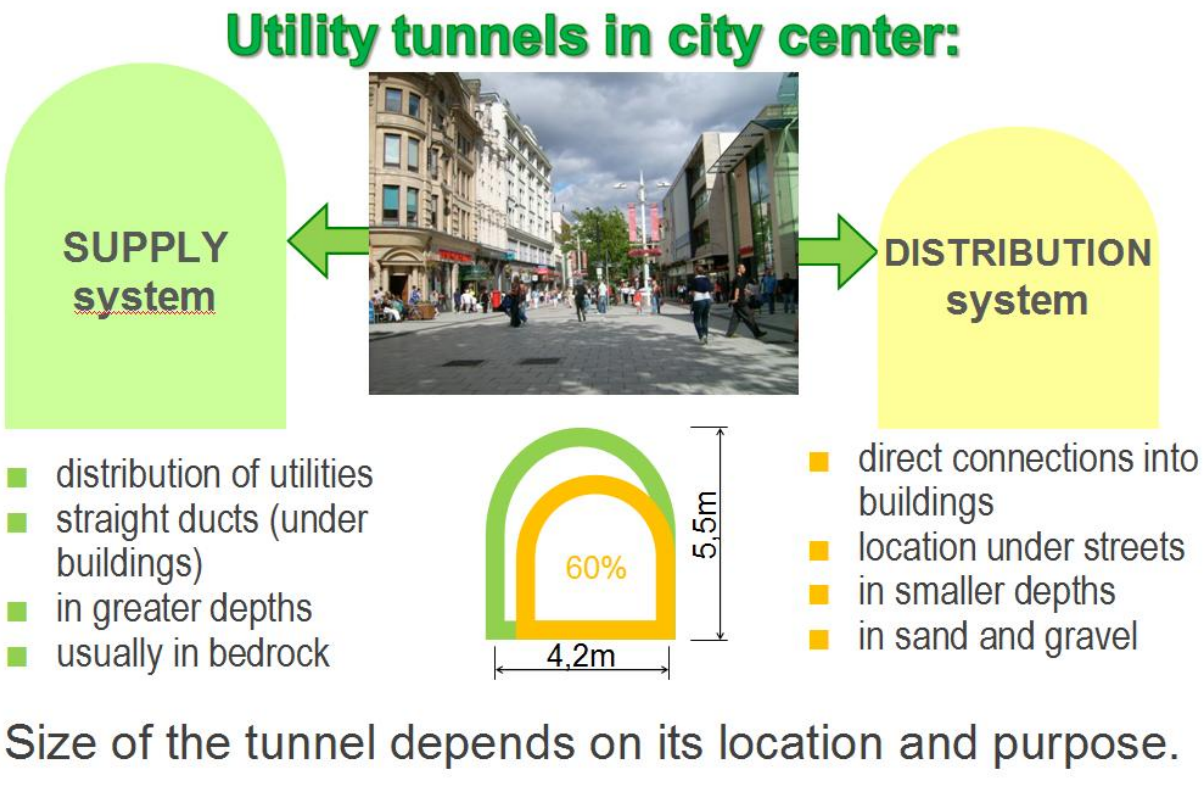
Construction technology	total km
CUT AND COVER - Rezidential areas	62,9
MINED - City centre	17,6
TECHNICAL Chambers	7,3
Short crossings under the roads, railway tracks, etc..	2,8
Total km	93,6

System concept of the underground services ducts

T**ec**hnical infrastructure design of every town district stems from its attractiveness within the town, type of development and required utility capacity and interconnection, considering planned extension of utility networks. Unlike local and partial activities associated with the design of transport infrastructure or construction of distribution networks in suburban housing areas, the system approach is applied to construction of these networks in city centre requiring plan-based development of an open system allowing its extension into other city districts in future and construction of branches to adjacent streets. In compliance with requirements and financial resources of the local government. The plan of underground services duct network is based on the city-centre duct network development plan which is a component of the historical town reserve development plan anticipating regeneration of individual networks and setting down development programs. Two types of underground services duct systems have been designed for the city centre of Prague:

- 2nd category ducts – supply - essential distribution networks (city-wide), laid deep and covering wider areas, with surface outlets in limited number of locations and blocks of houses. These ducts are intended to transport the media into individual city zones.
- 3rd category ducts – consumption - direct supplying individual buildings in close connection with the 2nd category ducts. As far as their layout and height are concerned, the 3rd category ducts significantly influence the surrounding area and are a big geotechnical challenge.

In both categories, the cables (high-voltage and communication), pipes (water and gas supply) and systems required for operation and control of underground services ducts are installed on internal steel structures. In the city of Prague, no sewage pipes are installed in the underground services ducts, however, some other cities make use of this option.

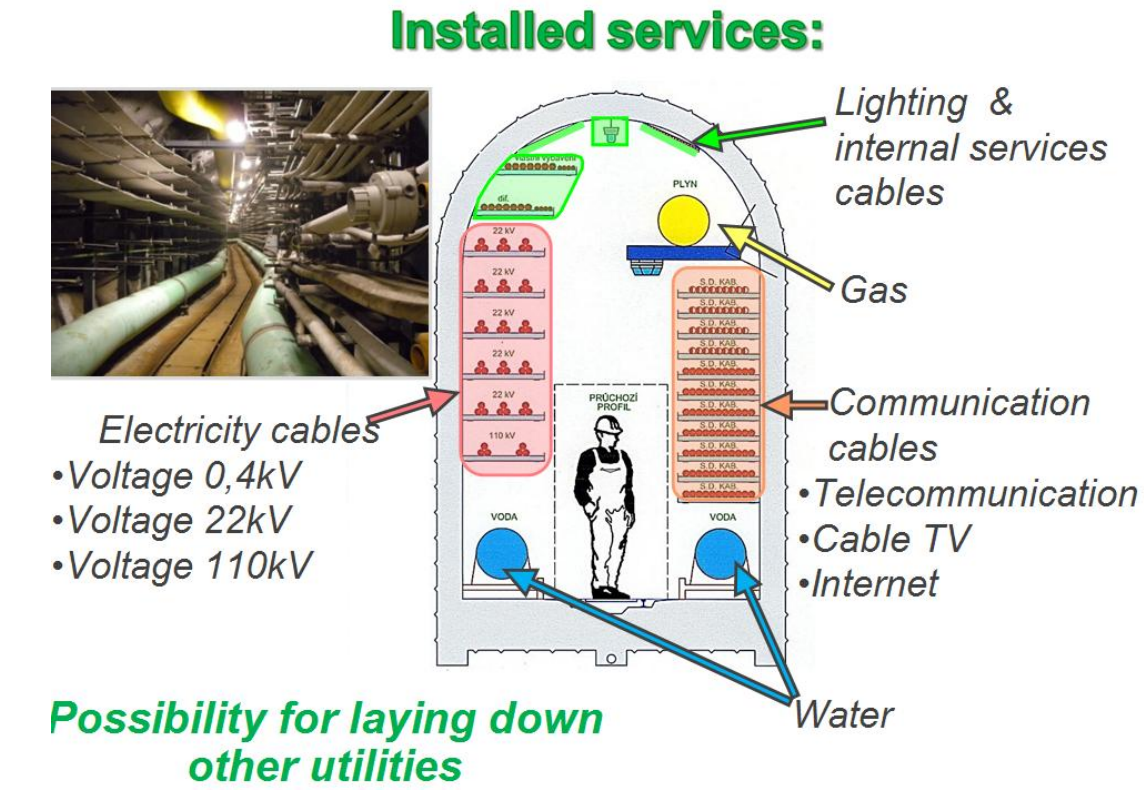


Limiting factors of underground services duct design

Underground structure design has to consider various factors related to utilization of the underground space (presently, the utilization is largely limited by existing service systems, adjacent buildings, traffic requirements and more).

3rd category underground services ducts (consumption) is line structures which arrangement and supplementary systems, as a rule, have impact on the surrounding area. In the course of projecting, decisions on location and route direction as well as height profile must be made. The decisions cannot be made under consideration of only one - though optimum - point of view of party to construction process (designer, contractor or operator). The final decision must comply with various criteria which have to be considered as a complex and optimized via a compromise because an optimum solution cannot be achieved in real terms and conditions.

Underground services ducts. The 2nd category underground services ducts, lay, as a rule, in direct routes deep below the grade in the rock substratum, in practical terms, are not limited by existing networks and city operation. Limiting factors of routing will be only those associated with tunneling works that could cause deformations of the surface and surface structures. However, they are more stringent and extensive for the 3rd category of underground services ducts. (The only exception is surface outlets of shafts involving contact with the networks above and the surface transport and operation corresponding with the limitations attributable to the 3rd category underground services ducts.)The preliminary project documentation is intended to demonstrate the feasibility of proposed routes of utility ducts with maximum consideration of above-indicated factors, to minimize possible clashes. These criteria allow to analyze the environmental impact of the construction technology and to comply with other requirements, e.g. durability and utilization of the work (constructional and operational safety, financial aspects of the construction and operation of underground services ducts).



I. CONCLUSION

This outline of points at issue shows a new aspect of underground services ducts allowing inspections, modifications and repair is made without adverse impact on the environment. This impact can be largely reduced by selection of suitable construction technologies. The design and construction require systems approach and comprehensive concept of the work. In the long-term perspective, the operation of underground services ducts will be of significant benefit for the environment.

ACKNOWLEDGEMENT

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