ASSESSMENT METHODOLOGY FOR UNDERGROUND SERVICES CONSTRUCTED BY MEANS OF TRENCHLESS TECHNOLOGY FROM THE ENVIRONMENTAL POINT OF VIEW

Lucie NENADÁLOVÁ
Centrum výzkumu Řež s.r.o., Hlavní 130, Husinec – Řež, 250 68, Czech Republic, nea@cvrez.cz

Summary

The Trenchless technology is a technology allowing for the construction and restoration of utilities with minimal disruption to surface traffic, business, and other activities. This paper describes the methodology of assessing the construction of utilities employing trenchless and traditional ways of construction in terms of environmental impact.

The basis for the methodology creation is the analogy with assessing the environmental impact of building constructions, which is now being monitored absolutely and relatively. The impact of the construction of utilities is monitored through the environmental, economic and technical specifications covering all construction activities during the construction and installation.

By evaluating the actual buildings, the most important parameters have been found affecting the method of construction and selection of particular trenchless technologies. All the quantified parameters of the construction are aggregated into five basic groups – materials, machinery, transportation, utility installation, and externalities including the comparison of the materials commonly used for construction of utilities, transportation of machines for trenchless technologies and their production, construction alternatives and installation of utilities. By converting the technical and economical parameters of the construction into primary energy sources and then transferring them into measurable, from the environmental point of view, quantities according to the emission factors, we get the amount of consumed of emissions. Within the methodology, the amounts of carbon dioxide CO_2, carbon monoxide CO, nitrogen oxides NO_x, sulphur dioxide SO_2, particulate matter and organic matter are evaluated and that way, an instant overview of the effects of particular technologies on the environment is obtained.

By comparing the actual constructions, we discover the difference in the emission consumption for trenchless and excavation technologies and thus the environmental appropriateness of a given alternative of utility installation.

Keywords: Decision tool, Assessment methodology, Energy consumption, Emission

1 Introduction

Utility investors, municipalities, water and sewerage companies, and gas companies, when considering the options for laying, rehabilitating or repairing utilities, often decide on which technology is optimal to use from the wide range of trenchless technologies, or whether it is better to use a conventional technology for installation (Act No. 83/2006 Coll., 2006). There is no comprehensive overview of the technology parameters for the investors that would

guide them through the decision process regarding the method of construction. If the decision-making process includes environmental criteria, the advantages of particular technologies when compared to traditional utility installation methods, or their mutual comparison, are not yet known.

Construction projects implemented in various sectors of civil engineering begin to monitor environmental parameters, both qualitative and quantitative. The constructions are monitored particularly in terms of deciding on the implementation (EIA), but the possibility to compare different alternatives with various environmental stresses is also being introduced (Act No. 100/2001 Coll., 2001).

There are analogical solutions to the environmental impacts of constructions. For example, environmental impacts of building constructions are now frequently monitored both in absolute and relative terms. Relative comparison allows simplifying the calculation as in relative comparison, only the differential parameters and values are observed, not all parameters. In the standard 73 0540 Thermal Protection of Buildings, or for example in the subsidy program Green Light to Savings, the buildings in a low-energy or passive standards are compared with a so-called reference building which has pre-defined parameters. Similarly, trenchless solutions can be compared with a conventional excavation solution where the compared values for the excavation solution are standardized (e.g. per 1 running meter of sewer DN 200) and the differential parameters and values of both solutions are compared. It is also possible to compare trenchless solutions with each other. By comparing the environmental parameters, the alternative with the lowest environmental impact can be determined.

2 Development of methodology

Development of methodology is based on rigorous analysis of both the works carried out employing the excavation method (the traditional way of construction) and trenchless one. A partial step was to identify the environmental criteria that have been tested for various technologies and then tested on real buildings. For the development of methodology, the decision analysis has been used to select the possible technologies for the project. By using the environmental criteria and their transferring to the items of the calculation formula and regrouping into the following parameters: materials, machinery, installation of utilities, transport, and externalities and the primary energy conversion and transfer to the environmental factors of carbon dioxide CO_2, carbon monoxide CO, nitrogen oxides NOx, sulphur dioxide SO2, solid pollutants and organic substances, we receive a suboptimal solution for the construction, see Figure 1.

3 The decision-making process

The decision-making process for selecting the most appropriate method of construction and selection of appropriate trenchless technology uses an elimination decision method – K.O. decision system (Heralová et al., 2012). To create the methodology, "data sheets" have been prepared which include the following: basic technical description of the specific trenchless technology, potential materials used, limiting conditions, machinery used, clarifying requirements for cleaning, possibility of implementation without traffic disruption, implementation time schedule, service life of the new works, streamlining the application risks, sensitivity of technology to elements, sensitivity to the quality of the cleaned pipe, geological conditions, environmental criteria, size of the starting and target pits, progress

and time schedule, space limitations, restrictions on construction, operation and maintenance conditions, service life, possibility of installing branches, pulling radius.

By comparing the technical and environmental criteria for trenchless technology employing the K.O. decision system, we get a selection of technologies applicable to a particular construction.

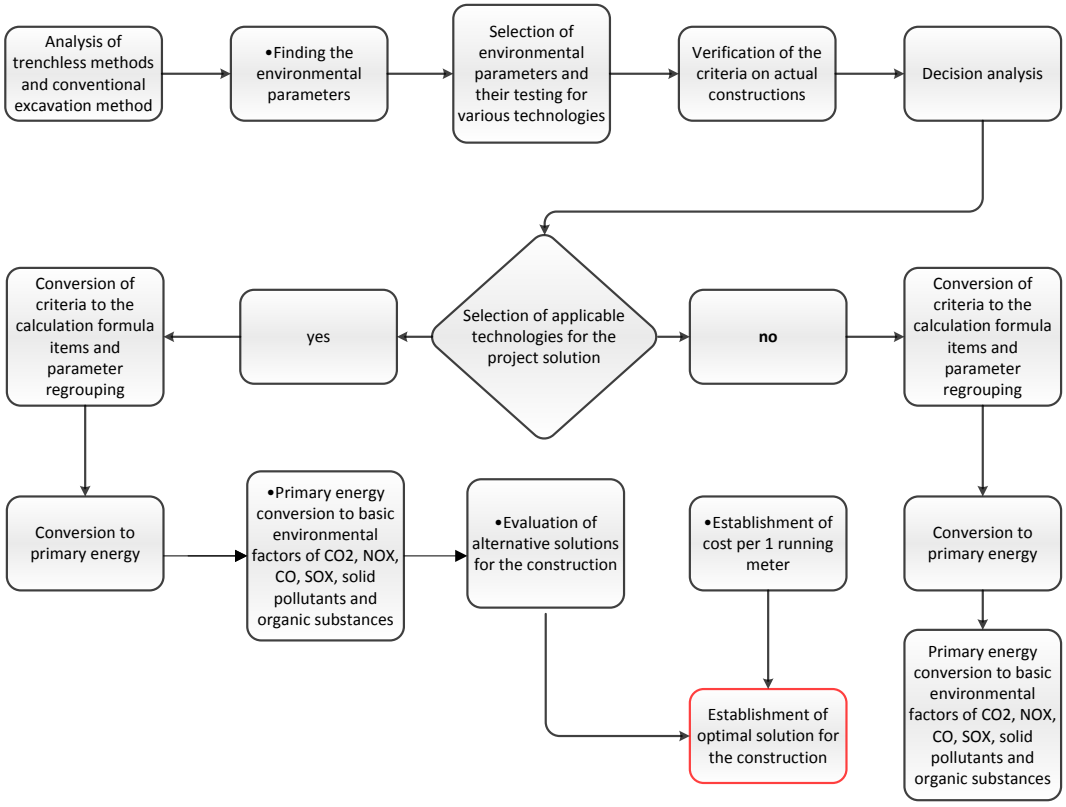

Fig. 1 *Methodology Development Process Diagram. Source: Author*

After selecting the appropriate technology for a given construction, the construction is further evaluated according to the bill of quantities. The methodology deals with the comparison of materials used in terms of energy need for the production of the materials used for the utility construction and thus by their indirect effect on the environment. The next evaluation item is the transportation of machines for trenchless technology; for larger pipe diameters, the equipment is transported from considerable distances, which does not have entirely positive impact on the environment in terms of emissions consumed and the production of the machines for trenchless technology also represents a burden. Another construction parameter is the actual implementation of construction works, and namely the speed of the construction implementation, which is directly related to time of the deployment of the machines on site, where there are significant differences in the construction methods used (Baugeräteliste Technisch-wirtschaftliche Baumaschienendaten, 2007). The methodology also quantifies the possible externalities. Within the methodology, traffic restriction on the road, or its complete closure, is considered an externality. Also regarded as externality is traffic interruption on the railway with the necessity of introducing a replacement bus service. The methodology parameters were calculated as the amount of energy consumed for the production of materials and machinery and through their conversion according to the emission parameters used in the Czech Republic, the amounts

of consumed emissions – solid pollutants, sulphur dioxide, nitrogen oxide, carbon monoxide, and the most monitored greenhouse gas, carbon dioxide, were found.

4 Comparison Assessment Methodology with LCA

LCA (Life Cycle Assessment) methodology assesses the environmental impact of product during their entire life cycle (Kočí, 2009). The assessment methodology described in this paper is focused on the phase of utility construction implementation in detail which is different for each possible construction alternatives in contrast to their entire life cycle and in advance includes externalities. It was find out in examples that externalities are the important parameter for the selection the most appropriate technology from the environmental point of view.

5 Conclusions

Trenchless technologies show great diversity, which is ideal for their application for the vast majority of utility constructions. The decision-making process for technology selection has to stem from the comparison of objective parameters of the construction to achieve the best selection of solutions for implementation. When searching for parameters, it was found that not only the environmental parameters should be taken into account, but also the basic technical parameters of the route, in order to compare the individual technologies and to quantify them in terms of the environmental parameters.

When deciding on the option of the technology used for laying utilities or their rehabilitation, an environmental assessment is very useful.

Acknowledgement

This work has been supported by the SUSEN Project CZ.1.05/2.1.00/03.0108 realized in the framework of the European Regional Development Fund (ERDF).

References

[1] ARIARATNAM, S. (2009). *Calculating Airborne Emissions in Underground Utility Projects*, Journal of Trenchless International, Issue 5, pp. 26–33.

[2] Baugeräteliste Technisch-wirtschaftliche Baumaschienendaten, Bauverlag BV GmbH, Gütersloh, 1. Edition 2007, ISBN 978-3-7625-3619-2.

[3] HERALOVÁ SNEIDEROVÁ, R. and BERAN, V. and DLASK, P. (2012). *Decision Making (Rozhodování)*, Praha, ČVUT, 2012, ISBN 978-80-01-04982-2.

[4] THEWES, M. and BIELECKI, R. and KAMARIANAKISK, S. (2011). *Analyse zur ökologischen und ökonomischen Bewertung offener und geschlossener Bauweisen zur Herstellung unterirdischer Infrastrukturmaßnahmen.* Proceedings of Oldenburger Rohrleitungsforum 2011, Oldenburg, February 10–11, pp. 372–386. ISBN 978-3-8027-2855-6.

[5] KOČÍ, V. (2009). *Life Cycle Assessment – LCA (Posuzování životního cyklu)*, Vodní zdroje Ekomonitor, spol. s r.o., Chrudim, 2009, ISBN 978-80-86832-42-5.