TTWORLD: A WEB-PORTAL FOR ASSESSING THE SUITABILITY OF TRENCHLESS CONSTRUCTION METHODS FOR UTILITY PROJECTS AND ASSOCIATED SOCIAL COST SAVINGS

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Abstract

The Trenchless Technology Center, in collaboration with industry associations, has developed comprehensive, yet easy to use interactive software for the evaluation of alternative construction methods that can be employed in the installation and rehabilitation of buried pipes (gravity driven and pressurized) and manhole structures utilized in municipal applications. The decision support software was implemented in an on-line format, so it can be accessed simultaneously by multiple users over the internet via a web-portal named TTWorld. A Social Cost calculator was added to the web-portal to assist users in estimating the social costs associated with the various construction methods. The software is updated regularly to include emerging and evolving technologies and materials, and is available in both, English and Spanish. Future developments will focus on enabling the software to accept input data directly from relational databases associated with commonly used GIS software packages.

Background

The Trenchless Assessment Guide (TAG) represents the most extensive method selection software of its type currently available in North America. The program takes into account extensive performance data of nearly 70 construction methods and processes used in the installation and rehabilitation of buried pipes (gravity driven and pressurized), conduits and manhole structures. Designed to assist municipal and utility engineers in evaluating the technical feasibility of various construction methods for a specific project, the software emphasizes simplicity and practicality, and limits input data to those readily available to utility and municipal engineers at the design stage of the project. Based on the specific characteristics of the problem(s) facing the decision-maker, the software performs a preliminary screening, eliminating technologies unlikely to meet the project’s requirements. Next, a technical evaluation is undertaken, during which technical attributes of technologies identified in the first step are compared with the project’s requirements in a systematic manner. If an installation along a new alignment is required, the perceived risk associated with each technically compatible construction method is evaluated based on the project’s environment (i.e., rural, urban, environmentally sensitive), the construction method track record, availability of consensus-based specifications and similar considerations. The model output consists of a list of technically compatible
construction methods ranked by an ascending order of their perceived risk score. The rehabilitation methods are listed as options for the user to pick from solely based on compatibility with the project technical specifications and conditions. TAG was developed in collaboration with the National Utility Contractors Association (NUCA) and TAG-R (Rehabilitation) with the National Association of Sewer Service Companies (NASSCO). Both applications were subjected to rigorous technical reviews by industry professionals as well as an extensive validation effort, where the software recommended construction methods were compared with trenchless construction methods utilized, successfully and unsuccessfully, on 20 geographically diverse projects performed in various geological and hydro-geological environments.

TAG Online

Following their completion, the two decision support software were integrated to form a single application. The most effective approach to make the software widely available and easily updatable (‘live document’) was to implement it within an online environment. TAG Online combines the capabilities of the original TAG software, which focused on new installations and in-line replacements, with TAG-R which was developed for rehabilitation of pipe mains, laterals and manhole structures. TAG Online is currently available over the world wide web for a Beta testing period, allowing the solicitation of feedback from users around the world regarding content, format and any additional features users might wish to have.

The evaluation begins by selecting the type of utility system under consideration. The user is then asked to select the type of construction that needs to be considered which can be any combination of new installation, inline replacement or rehabilitation (either access point to access point or spot repair). The number of localized repairs needed for a given line will also be input to determine if spot repairs methods are applicable. Figure 1 shows the structure selection input screen for a project, considering an inline replacement or rehabilitation.

![System Selection](image)

**Figure 1. Structure selection screen for TAG on TT World.**
Two case studies presented in the following sections demonstrate the capabilities of the software. Other case studies can be found in Matthews et al. (2007). In January of 2006, the City of Calgary, AB, Canada, was trying to identify a suitable repair methodology for a deep sewer located in the downtown area (Brady and Chan, 2007). The gravity driven sewer was a 95 m. (300 ft.) long, 600 mm. (24 in.) diameter vitrified clay pipe, with an average depth of about 6 m. (20 ft.). The ground water was assumed to be at a depth of 6 m., and a high degree of pipe placement accuracy was specified for both horizontal and vertical alignments, as it is a gravity driven pipe placed in a utility congested area. Based on CCTV inspection data it was concluded that the host pipe was fully deteriorated, and thus a structural solution capable of resisting earth loads, any relevant live loads and the hydrostatic pressure applied by the groundwater was needed. Furthermore, the CCTV data suggested that the existing pipe does not suffer from excessive sags or misalignment. The input form for the inline replacement data is shown in Figure 2.

![Figure 2. Construction parameters for Calgary project.](image)

Soil conditions and the host and new pipe details are input next. Typical soil conditions in Calgary’s downtown area consists of river valley flood plain deposits (a mix of sand and gravel). As for the replacement pipe, PVC and HDPE pipes were considered as the best options. Also, the project called for a size to size replacement (i.e., no upsizing of the host pipe). The pipe installation details screen is shown in Figure 3.
The detailed project data was input into TAG On-Line, which identified static pipe bursting as the least risky construction approach. TAG also identified structural cured-in-place pipe (CIPP), structural folded pipe and spiral wound lining as viable rehabilitation technologies for the pipe in question (see Figure 4). The City of Calgary initially selected static pipe bursting as the construction method of choice for this project, but decided to opt for pneumatic pipe bursting once it was determined that no utilities were sufficiently close to be disrupted by the method and the project was completed successfully, on time and budget.

It is important to note that while the input information required by TAG is extensive, it is not exhaustive. Thus, the software is intended to serve as a design tool, eliminating methods that are clearly ill-suited for the application at hand, while potentially identifying emerging approaches originally not considered by the designers.

In addition to its role as a screening tool, TAG On-Line is also a valuable educational tool, allowing decision makers to evaluate potential benefits from utilizing trenchless techniques on their projects, and/or making them aware of the introduction of emerging technologies or the growing capabilities of existing ones. Trenchless technology is a global, rapidly evolving industry. The authors envision TAG On-Line as the place where municipal and utility engineers and designers go to confirm they did not overlook an alternative method for a standard project, as well as to seek
potential solutions for a uniquely challenging projects, for which ‘cookie-cutter’ approaches do not suffice.

Figure 4. Results screen for the Calgary sewer improvement.

TAG is also capable of identifying suitable manhole rehabilitation methods based on standard condition assessment data. The evaluation is based on the following conditions: level of infiltration/inflow, level of corrosion, structural integrity, and the condition of the bench and invert. This capability is demonstrated by assessing the following project undertaken by the City of Columbus in 2003.

Segment 1 of the Franklin-Main interceptor sewer consists of 580 m. (1900 ft.) of 600 mm. (24 in.) vitrified clay at depths of up to 5 m. (15 ft.) that was originally constructed in 1913 (Siegfried and Coffey, 2004). The sewer extends through heavily developed residential areas and is adjacent to the Olentangy River. Review of CCTV images revealed that between a third and a half of the sewer cross-sectional area was filled with debris. The maximum ovality in the host pipe was less than 10% and the pipe was considered to be only partially deteriorated. It was also decided that bypassing of the line for the duration of the project was doable. There were no significant bends (greater than 12°) in the host pipe or cross-section transitions. The design report concluded that the entire length of the pipe should be rehabilitated using CIPP, and each of the existing manholes rehabilitated with cementitious linings to
improve their structural integrity. The input form for the manhole evaluation is shown in Figure 5.

![Manhole Conditions](image)

**Figure 5. Input of manhole conditions.**

The program suggested that only CIPP or a Spiral wound liner could be used to rehabilitate the 580 meters of interceptor sewer in a single operation. While identifying cementitious coating as a viable rehabilitation method for the manholes, TAG suggested that several alternative approaches might also be deemed adequate for this project (see Figure 6).

![Manhole Rehabilitation Methods](image)

**Figure 6. Manhole rehabilitation methods.**
TAG is primarily a tool used for identifying trenchless construction methods that are compatible with a given project. However, open cut methods are in many cases viable options for utility installation or repair projects. One major factor that needs to be considered when comparing trenchless and open cut methods are social and indirect costs associated with conducting lengthy, disruptive construction activities in congested urban areas. Indirect costs include increased travel time due to traffic disruption, productivity loss, business losses and intangible “quality of life” issues (Boyce and Bried, 1994).

The Calgary project mentioned previously discounted open cut methods due to resulting road closures, long traffic delays, frustrating detours, loss of access to homes and businesses, unsightliness, noise and disruption to the general public (Brady and Chan, 2007). The social cost calculator included in the software could be used to obtain a quantitative estimate of these costs based on historical data and proven algorithms.

The calculator attempts to quantify social costs that have been previously estimated by researchers in a single unified algorithm. Gilchrist and Allouche (2005) compiled algorithms proposed by researchers around the world for calculating social costs such as traffic delay costs and vehicle operating costs. Pucker et al. (2006) examined pedestrian delay costs, dust and dirt control costs, air pollution costs, noise pollution costs, loss of parking revenue and compiled a database of unit cost ranges that can be adopted in social cost analysis. Xueqing et al. (2008) proposed a bid evaluation method considering social costs for urban construction projects based on fuzzy sets computational approach. The calculator also takes into account indirect costs such as reduced service life of pavement structures and associated restoration costs.

A first-order estimate of direct construction costs is obtained using an extensive bid price database of utility projects constructed across the US using various trenchless methods, which was compiled by the TTC over the past several years. The cost for open cut construction methods was obtained from industry estimating tools such as RS Means construction cost database. The ratio of indirect (or “social”) costs to the sum of the direct and indirect costs, is the fraction social costs represent of the project overall cost. The authors believe that this ratio, coupled with other parameters such as the degree of urbanization and the zoning of the construction area, could serve as a key measure for establishing acceptable levels of adverse impacts for different types of construction projects.

**Conclusion**

TT World now hosts one of the most comprehensive construction methods evaluation tool for utility type projects. TAG and TAG-R have been combined to provide the user with a complete tool for evaluating trenchless construction methods for performing new installations, inline replacements, and rehabilitations of gravity driven and pressurized pipes as well as laterals and manhole structures. A social cost
calculator helps the user evaluate trenchless versus open cut methods by taking into account the indirect costs associated with cut and cover activities in developed areas. The software is available at http://138.47.78.37/rtag/ and can accessed by Username: ttc and Password: ttc123. The authors will greatly appreciate commentary and suggestions by the municipal and utility engineering community that will enable them to further enhance the application. Accessible via the world wide web, TAG On-Line serves as a gate to the world of trenchless technology for potential users around the globe, serving as an ambassador of the trenchless industry.

**Acknowledgment**

The authors would like to thank the National Utility Contractors Association (NUCA) and National Association of Sewer Service Companies (NASSCO) for providing financial support. Special gratitude is extended to NUCA’s Trenchless Subcommittee, under the chairmanship of Mr. Brandon Young, as well as NASSCO’s review committee led by its Technical Director Mr. Gerry Muenchmeyer. The authors would also like to give special thanks to Mr. Joseph Berchmans for his tireless work making this web portal a reality.
References


