TRENCHLESS CONSTRUCTION: AN EMERGING TECHNOLOGY IN UAE

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The results of a survey conducted among municipalities and leading construction companies across the United Arab Emirates, revealed that trenchless technology is gaining increasing popularity among contractors and owners across the United Arab Emirates. Trenchless technology is an emerging area of construction in United Arab Emirates involving innovative methods, materials, and equipment used for the installation of new and the rehabilitation or replacement of existing underground infrastructure with minimal or no need for open cut excavation. This technology provides an alternative to traditional methods of open trenching construction, which is often associated with major disruptions to surface activities.

Overview of Trenchless Construction

Trenchless construction is defined as ‘‘a family of methods, materials, and equipment capable of being used for the installation of new or replacement or rehabilitation of existing underground infrastructure with minimal disruption to surface traffic, business, and other activities.’’ The extensive use of trenchless construction for the installation, repair, or replacement of underground utility infrastructure is a relatively recent development; however, the use of trenchless techniques dates back to the 1860s in North America, when Northern Pacific Railroad Company pioneered the use of pipe jacking techniques. By the 1930s, reinforced concrete pipe ranging in size from 1,070 mm (42 in.) to 1,830 mm (72 in.) in diameter had been installed using this technique. Thereafter, other methods of trenchless construction began to be utilized. This use, however, was very limited due to the less-accuracy and high costs associated with the use of this technique.

In the 21st century, utility companies and local municipalities are faced with the tremendous task of maintaining and expanding their utility infrastructure (i.e., power, telecommunications, water mains, and sewer). Traditionally, the installation, inspection, repair, and replacement of underground utilities involves open trenching construction methods. Such operations may be proven expensive, particularly in congested urban areas. Contractors must cautiously dig while maneuvering around other utilities to achieve the required depth, which in turn slows down the operation. Additional costs are typically incurred by the need to restore the existing surfaces (i.e., sidewalks, pavement, brick paving) and repairs resulting from ground settlement. Aside from the associated high agency costs, open cut trenching operations often result in high user, or ‘‘social,’’ costs due to the disruption to traffic and adverse impact on nearby businesses (Boyce and Bried 1994; Thompson et al. 1994; McKim 1997). Faced with the urgent need to rehabilitate or replace aging utility systems on the one hand, and dwindling revenues, increased environmental regulations, and increased emphasis on user costs on the other, municipalities and utility companies are beginning to seek alternative methods for repairing and replacing their underground assets. The answer may be provided in the form of trenchless construction—a family of methods, materials, and equipment that can be used for the installation of new, or the rehabilitation of existing, underground utility services with minimum or no excavation requirements. Trenchless technology systems for underground utility services fall into three broad categories: 1) installation of a new pipeline or duct, including dealing with service connections; 2) on line replacement of an existing pipeline or duct; and 3) renovation of an existing pipeline or duct.

Methods for the installation of a new pipeline or duct, including dealing with service connections, are: microtunnelling, short drive systems, horizontal directional drilling, and guided drilling.

Microtunnelling is used for controlled mechanical tunnelling systems less than 1000 mm diameter where the spoil is removed from the cutting head within the new pipeline which is advanced by pipe jacking (Iseley and Najafi 1997), as shown in Fig. 1. Short drive systems (Fig. 2) are used for crossings of obstacles. Even in open country where a trenched pipeline may provide a least cost solution, there is often a need for short crossings of obstacles. Short drive systems include auger boring, impact moling, rod pushing, pipe ramming, and thrust boring. Horizontal Directional drilling systems were originally developed by the oil industry for river crossings of small diameter where no high degree of accuracy was required. They are now widely used for installing pressure pipes under major obstacles such as motorway intersections, large rivers and airport runways (see Fig. 3). Guided drilling (Fig. 4) employs an excavation or soil displacement head with compact light weight rig for rapid mobilization. Small diameter jets, mechanized cutting tools or displacement heads attached to a flexible drill string are positioned to form a bore as the head is thrust forward. The drilling head is launched from the surface at an inclined angle. Steering, in both vertical and horizontal planes, is effected by controlling the orientation of a slant face at the head.

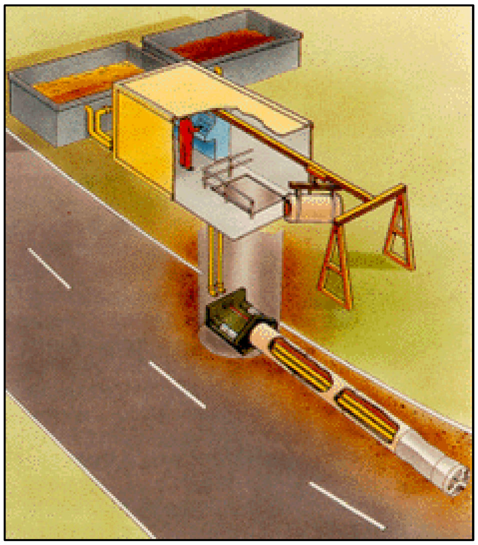

Fig. 1: Microtunnelling System.

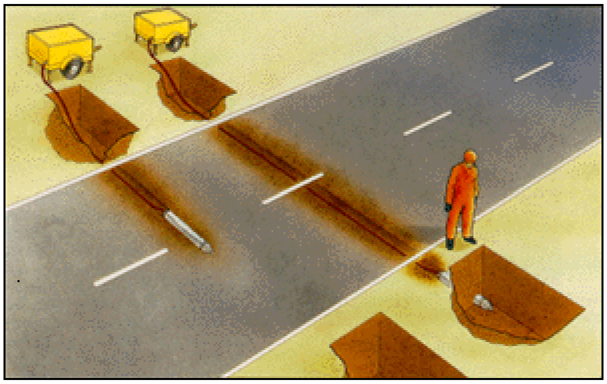

Fig. 2: Short Drive System.

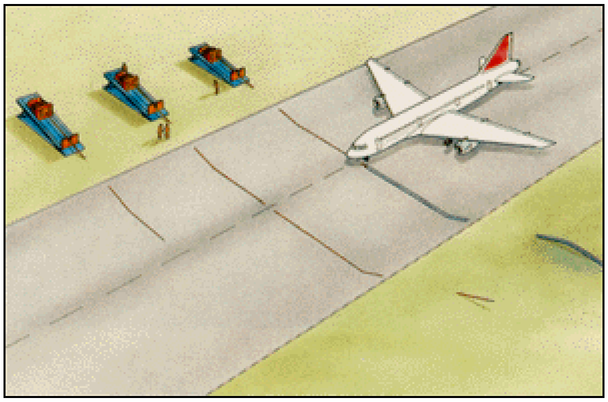

Fig. 3: Horizontal Directional Drilling System.

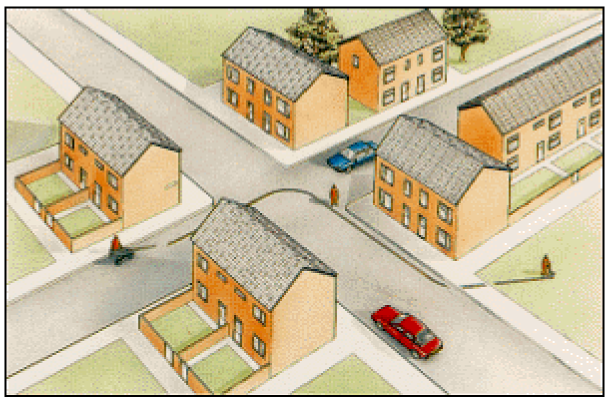

Fig. 4: Guided Drilling System.

Methods of on line replacement of an existing pipeline or duct include pipe bursting and pipe eating (Strychowskyj 1997). Pipe bursting, sometimes called pipe splitting, is used in urban areas the top 1m below the surface is often congested with existing services and chambers (Fig. 5). This allows little scope for replacement of a defective service on a new line. The existing hole in the ground thus becomes valuable as a route. Pipe bursting has been developed to exploit this resource. Initially the aim was for size-for-size replacement by splitting the defective pipe and displacing the fragments to enable a new pipeline of the same diameter, usually of polyethylene, to be drawn in. However, many defective sewers were found also to be overloaded and replacement sewers of increased capacity were required (Harper 2001). Pipe eating, on the other hand, is an on-line microtunnelled replacement technique. The existing defective pipeline is crushed and removed through the new pipeline. Lateral connections must be disconnected in advance and may be replaced by rider sewers or reconnected by angled drilling.

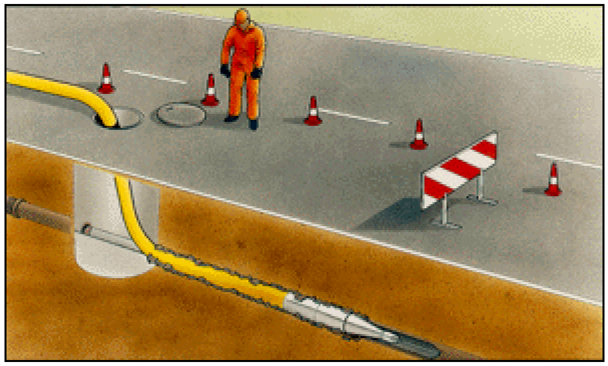

Fig. 5: Pipe Bursting System.

Where the performance of the pipeline is unsatisfactory, but the fabric has a residual value, either structurally in its own right or as a lining support, renovation may be appropriate. An essential preliminary is to determine the condition of the existing pipeline. From hydraulic analysis and structural inspection it may be concluded that a pipeline is structurally weak or structurally sound, but hydraulically defective. In either case it is often more economic to renovate the defective pipe than to provide an entirely new one. Renovation methods are sliplining, lining formed in place, spray-on lining, localized repair, and chemical stabilization (Howell 1995).

Associated with these systems are a number of essential services required prior to the selection of the trenchless system, in particular site investigation to determine soil and groundwater conditions; inspection to determine the condition of the pipeline; and location survey to determine the position of existing pipelines, other services and potential obstacles.

Selection of Contractors: An Important Step Towards a Successful Project

In trenchless construction, selection of contractors is important for a successful project as well as a responsible use of public funds. Two popular methods of contractor selection are the use of specifications and contractor prequalification. Currently, established guidelines or specifications for contractor selection are not widely used. Prequalification, on the other hand, is a useful method to assist in the selection of contractors that have the capacity to perform the project. According to the aforementioned survey, prequalification is used on all contractor selection regardless of whether or not it was a trenchless contractor. Currently, most of the government authorities use the same prequalification methods for trenchless contractors as they used for nontrenchless contractors. Furthermore, in the selection of a contractor, there are six major factors that contribute to the final decision. These factors are: availability of adequate bonding, safety program, innovations in design or construction methods, previous experience, equipment availability, and locality. As a minimum requirement, owners should make sure that these factors are considered and evaluated during the analysis and prequalification process of trenchless contractors.

Future Growth and Concluding Remarks

The use of trenchless technologies is expected to increase as more contractors and owners become familiar with their applications and aware of their advantages. The growth in trenchless construction methods has been inspired by the many benefits of this technology. Trenchless technologies allow for the completion of complex underground infrastructure projects in congested urban areas in a safe and economical manner with minimal disruption to surface traffic, nearby businesses, or environmentally sensitive areas. This growth may be accounted for by several reasons. First, as trenchless technologies mature, they have become more sophisticated, cost effective, and accurate. Second, trenchless technologies provide an environmentally friendly approach to performing work that would have traditionally been performed by open cut methods. Finally, underground congestion of utilities is on the rise making the installation of deep utilities increasingly more difficult, as there may be several levels of utility corridors encountered at shallower depths. Each utility must be supported during excavation and then carefully backfilled to protect it from damage or future settlement. This results in open cut excavation being expensive and slow in congested underground areas. By utilizing trenchless solutions, some of these costs and difficulties may be avoided. Another key factor for the acceptance of trenchless technologies, and its wider use in the the United Arab Emirates, is education and sharing of work experience by engineers and others that hold positions where decisions regarding the use new technologies are made.

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