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Sensitivity Analysis and Productivity Study of *Directpipe* Technology by Using Simulation

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Abstract

Many techniques of trenchless technologies have been evolved over time to install, maintain, and manage underground infrastructure system, but all of these fail to satisfy implementer due to complex implementation process, economy, and adaptability to different geological conditions. Directpipe technology is one of new technology that has been invented by German's Herrenknecht Inc. recently. It claims that the technology is economical, fast, and has a single step installation procedure. The objective of this paper is to analyze and evaluate that claim by using CYCLONE model simulation. The simulation is used to compare the Directpipe technology with traditional trenchless technology by incorporating real costs and duration into the model. Sensitivity analysis is carried out to find out a suitable combination of resources delivering utmost productivity.

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Keywords: trenchless; micro tunnelling; horizontal directional drilling.

1. Introduction

Many techniques have been evolved over the time to install, maintain and repair underground infrastructure system. Open cut method is one of such old technology which had been used initially. But the method proved to be uneconomical, ineffective in context of developed urban area where more buried utilities being installed. Trenchless technology has been emerged as solution to open cut method. Horizontal directional drilling (HDD) and Micro tunnelling are two trenchless technology methods which have

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been used recently. These methods are successful in eliminating drawbacks of the open pipe method but they found to be limited by depth of cutting, geological layers and multistep complex installation process. So there is need for technology which can be used widely in case of different geological conditions, extend to any depth of cut and efficient over existing HDD and Micro tunnelling techniques (Bennet *et al*., 1999).

Direct Pipe technology is developed by German based tunnelling system company 'HerrenknechtInc'. Direct pipe technology combines advantages of well established two trenchless technologies one is horizontal directional drilling (HDD) and Micro tunnelling. The direct pipe method made its debut after crossing of the river Rhine in Worms Germany(Pfeff, 2008).

The purpose of this paper is to: (1) determine the productivity of the system and compare it with productivity of the system obtained in the field, (2) compare the *Directpipe* technology with conventional trenchless technologies in terms of cost, productivity, and application in context of geological pattern, depth of cutting and method of implementation, and (3) determine sensitivity of the system with respect to change in management controlled variables to achieve maximum productivity.

2. *Directpipe* Technology

On a site, the *Directpipe* method has some main elements such as cranes, pipe storage, section preparation area, welding and cutting machine, backhoes, bentonite pump and mixing tank, spoil storage tank, control office, separation unit, and water overflow tank (Pfeff, 2008).

A pipe thruster is the main elements in the *Directpipe* technology. It is setup inside launch pit. The thruster is fixed horizontally as well as vertically by using steel beams and anchors so as to transfer the thrust forces to surrounding soil. Thruster can deliver average thrust force of 15 t to maximum 28 t to the Direct Pipe machine above it. Fig. 1 shows a pipe thruster.

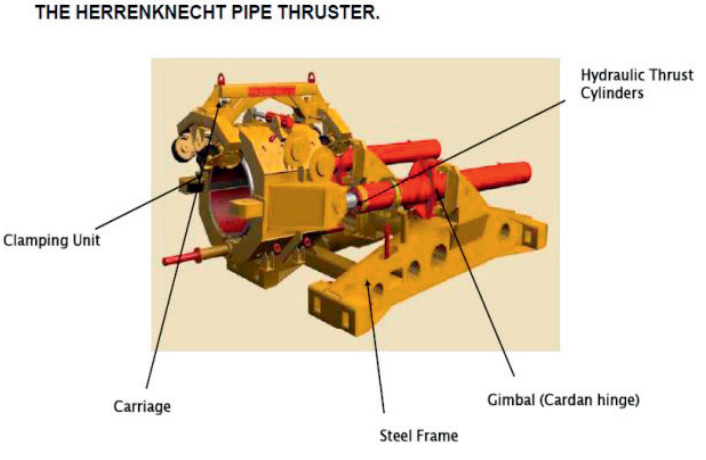

Figure 1. The Directpipe machine: Pipe Thruster