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Research needs for new construction using trenchless technologies

D.N. Chapman [a,*], C.D.F. Rogers [a], H.J. Burd [b], P.M. Norris [c], G.W.E. Milligan [d]

[a] Department of Civil Engineering, University of Birmingham, UK
[b] Department of Engineering Science, Oxford University, UK
[c] Mott MacDonald, Croydon, UK
[d] Geotechnical Consulting Group, London, UK

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Abstract

This paper presents a considered view of research needs associated with new pipeline construction using trenchless techniques, such as pipe jacking, microtunnelling and horizontal directional drilling. These research needs were compiled by core members of NETTWORK prior to, and then debated at, a UK workshop involving those with specific interests in the topic from academia, industry and other stakeholders. The aims of the workshop were to assess whether the suggested needs were accurately stated, to determine whether there were any omissions and to attach a priority to the research needs. This was achieved by a process of debates and subsequent voting. For convenience, the issues have been categorised under the topic headings of generic issues, machine–ground interaction, pipes and joints, and associated works. In each case the important research studies that have been carried out, or were known to be in progress, have been highlighted so that research needs could be assessed in this context and references have been made to the most important documents arising out of the studies.

The areas considered to be most important for research were: whole life costing of trenching and trenchless technology operations; issues associated with connections and laterals; mapping of underground infrastructure; multi-utility tunnels; drilling fluid reuse and disposal; improved modelling of ground movements; development of 'see ahead' technology; and the development of economic (remotely interrogated) sensors for pipes and joints. Work in many of these topics has since got underway.

Keywords: Trenchless technology; Pipelines; Construction; Research needs

1. Introduction

Novel pipeline construction methods using trenchless technology have been developed over recent years to install new pipelines and cables, such as sewers, pressurised water and gas pipes and cables. The techniques range from relatively simple percussive techniques to highly sophisticated processes involving balanced excavation or displacement of the ground ahead of the service insertion. The techniques have not been described in this paper as there are many references available on this subject (e.g. see Kramer et al., 1992; Milligan and Rogers, 2001; Stein, 2005).

This paper contains a list of research needs on the subject of new pipeline construction prepared as part of the Network in Trenchless Technology (NETTWORK). NETTWORK was funded by the UK Engineering and Physical Sciences Research Council (EPSRC) in the UK from 2000 to 2004 (Rogers and Chapman, 2005). It aimed to bring all relevant UK academics and a representative group of industrialists and other stakeholders together to

- synthesize knowledge in the broad field of trenchless technologies,
- agree on the research needs in a priority order,
- disseminate this information as widely as possible, and
- formulate research teams and proposals to address these needs.

* Corresponding author. Tel.: +44 121 4145150; fax: +44 121 4143675.
E-mail address: d.n.chapman@bham.ac.uk (D.N. Chapman).

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The scope of the present paper is:

(a) To review recent and current research on trenchless technologies related to new construction. The review is focussed, perhaps naturally, on research conducted in the UK, although relevant research conducted elsewhere is also reviewed;
(b) To identify areas where future research could usefully be done;
(c) To present the outcome of an exercise in which the research areas identified in (b) were prioritised.

With reference to (a), the paper provides a list of important references from which the research needs were primarily developed. The topic addressed herein was intended to cover all aspects of new construction using techniques such as microtunnelling, pipe jacking, horizontal directional drilling (HDD), simple percussive moling, steerable moling, auger boring and pipe ramming. Since they are very different in character, many of the research needs will be relevant only to some of the techniques. Nevertheless the paper has been written in an attempt to portray the issues generically rather than with any one specific technique in mind.

The research needs have been grouped into four categories:

- generic issues of planning, design and monitoring,
- machine–ground interaction,
- pipes and joints,
- associated works.

A workshop entitled 'Research Needs for New Construction using Trenchless Technologies' was held on 17th June 2003 at the University of Birmingham UK, with invited participants with appropriate expertise and/or experience from academia, industry and other stakeholders. A total of 23 delegates attended the workshop, of which 5 were from academic/research organisations, 9 were consultants, 3 were from client/owner organisations, 3 were from professional representative groups and 3 were equipment manufacturers. The suggested areas of research needs were initially developed by a core group of the members of NETTWORK, all of whom had conducted research in the area. This listing of research needs and recent past or current research was circulated in advance of the workshop to the workshop delegates, and each list in turn was introduced in plenary presentations. The lists were then subjected to detailed consideration in three parallel sessions, during which all topics were considered by the three smaller groups, such that items were added or removed until the full cohort of workshop attendees were satisfied that it was accurate. The lists were then rationalised and finalised at a further plenary session. Delegates were requested to prioritise the research issues, i.e. to establish their relative importance, with each delegate being given *thirteen* votes: *five* votes for 'generic issues', *five* votes for 'machine–ground interaction' and *three* votes for 'pipes, joints and associated works'. The outcome of the voting at the workshop is presented.

2. Generic issues of planning, design and monitoring

The research needs in this section relate to all aspects of the planning, site investigation, choice of technique, design (in a general sense) and subsequent monitoring. The construction operations and the specific issues of design relating to the construction techniques and pipes/joints are covered later. It should be noted that implicit in this section is a comparison with traditional trenching techniques for the construction of new buried pipelines and services.

2.1. Suggested areas of research need

The topics of interest to those contemplating the use of trenchless technologies are listed in Table 1. Not all are necessarily candidate subjects for research, but all will need to be considered in any research programmes that are developed, hence their inclusion in the lists. It should be noted that the political climate can influence greatly many of the following topics, examples of recent political initiatives in the UK and elsewhere being the Aggregate Levy, the Landfill Tax, Environment Agency pollution directives, concerns (extending even to bans) over the manufacture of PVC-u in some countries, concerns and legislation over asbestos cement (broadly whether to exhume or leave in place), lane rentals and restrictions on carriageway occupancy.

The results of the voting that took place during the workshop are also provided in Table 1. This indicates that the main priority areas concerning the generic issues of planning, design and monitoring, in order, are:

- whole life costing of trenching and trenchless technology operations,
- dealing with connections and laterals,
- multi-utility tunnels,
- mapping of underground infrastructure,
- long-term environmental issues,
- ground and surface layer displacements (hence stresses and strains), and
- adjacent buried infrastructure displacements (hence stresses and strains).

It is interesting that there evidently remains a need to justify the use of trenchless technology even after many years of successful use. The issue of connections and laterals has caused concern ever since trenchless technologies were first introduced, while the environmental issue has become increasingly important over recent years and yet was of minor concern when the technologies were first developed. Multi-utility tunnels are being ever