IMPROVED INSTALLATION METHODOLOGIES FOR EHV CABLES IN UNDERGROUND TUNNELS

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ABSTRACT

This paper outlines the development and use of a bespoke cable installation machine, the methodology and how it was successfully implemented in an underground 400kV cable tunnel project in the UK. Additionally this paper will also address the importance of training jointers in similar confined space environments in order to address best practices, maintain good workmanship, reduce manual handling and establish good logistical practices.

KEYWORDS

Cable Pulling Machine; Safety, Installation Design, Underground Cable Tunnels, Jointing, Dual Layer Sheath

INTRODUCTION

In the UK, major cities suffer from heavily congested roads and as a result the use of new underground cable tunnels to provide an environment to contain HV & EHV cable systems has become ever more popular in recent years. Working practices for conventional cable installation and jointing in both direct buried and ducted installations are well established and proven over the last 50 years. Installing cables in confined spaces such as underground tunnels changed the logistics and the approach on how these cable installation methodologies can be executed effectively, but more importantly safely.

Historically, cable installations in tunnels in the UK have been achieved with cable winches spaced throughout the tunnel at strategic positions, typically 1km apart. Not only is this method labour intensive and logistically difficult to plan, but exposure to long tensioned wire bonds throughout the tunnel gives rise to safety concerns for both workers and adjacent plant. In order to reduce the labour intensity and improve the safety of workers, Balfour Beatty Utility Solutions have undertaken the development of a bespoke mechanised Cable Pulling Machine for EHV cable installations in circular and flat invert tunnels ranging from 3m to 4m in diameter.

The installation methodology utilised and mechanised functionality of the CPM has been patented in the UK accordingly. The CPM has been successfully used in the new Beddington – Rowdown tunnel in South London, UK being approximately 10km in length having a 3m inner diameter, installing a single 400kV, 2500mm^2 XLPE circuit. The cable circuit has a vertical phase spacing of 500mm and is installed in a flexible formation supported on steel support brackets every 7.2m with intermediate short circuit straps between supports. The longest cable section lengths (prior to cutting & jointing) installed were approximately 1176m, being the record for this voltage in the UK to date.

CABLE INSTALLATION METHODOLOGY

The heart of a fully mechanised cable installation process was the requirement for a suitable machine capable of transporting the cable along the tunnel to the desired location of installation, lifting the cable into position and sagging it, with this all being automated to reduce manual handling and increase safety. In order to support the cable while being transported through the tunnel it would be necessary to either:

1. Install rollers on the cable support steelwork and intermediate supports, as used during conventional winch and bond pulling.
2. Use a rail located in the invert of the tunnel
3. Use a rail fitted to the tunnel.

All options were fully investigated and a mono-rail fitted in the crown seemed to be the most economical and safest solution, albeit the other options had their separate benefits. An additional driver for this option was the use of an inspection vehicle, supported by the mono-rail, by the client to inspect steelwork, joint bays and to carry out routine inspection post cable energisation.

In order to install a future circuit on the opposite side of the tunnel and avoiding the CPM having to turn around at shafts, the design philosophy was based on the CPM having symmetrical ends.

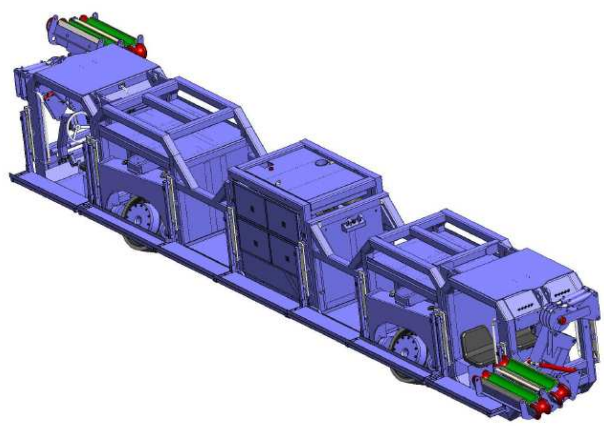

Fig. 1: Bespoke Cable Pulling Machine

The CPM consists of 5 modules, having a central power pack which contains the diesel engine, hydraulic pumps, fuel tank, hydraulic tank, filters, batteries and PLC which controls the machine's functions. Either side of the power pack, between the axles, are workstations equipped with