Introduction

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Crossrail is the engineering project of a generation. It expresses real confidence in the skills of the civil engineering profession and real ambition for the growth and future of London and the UK.

The railway Crossrail has designed and built – named the Elizabeth line from 2018 – is a high-frequency, high-capacity service linking 40 stations over 118km, from Reading and Heathrow in the west to Shenfield and Abbey Wood in the east. It increases central London's rail capacity by 10% and creates new routes into and through the city, giving 1.5 million additional people access to central London within 45 minutes.

To deliver the new railway, Crossrail needed to build ten new stations, transform eight existing stations and upgrade many more. These new stations, with improved public realm and developments above, are linked by 42km of new tunnels under London and improved railway infrastructure to the east and west of the route.

The project has been an incredible engineering challenge. Tried and tested technology and engineering principles have been built upon throughout to deliver it successfully. Crossrail is keen to share its own experiences and learnings and those of its supply chain for the benefit of the industry and future projects. This special issue of *Civil Engineering* covering design and construction is part of that initiative.

With an investment of value of £14.8 billion, the project required strong leadership, governance and a collaborative ethos to power many thousands of individuals toward a single goal – successful delivery of the Elizabeth line. The first paper by Tucker (2017) outlines the execution strategy for the programme. Articulating the sponsor structure, the primary design works and the procurement strategy for the programme, he explains how contractual relationships supported by strong controls, a shared set of values and assurance processes underpinned the strategy.

The design of the new railway was an iterative process having been envisaged decades before its final incarnation. The engineering design of the route and its new stations, informed by geotechnical data, safety and environmental considerations and managed by controlled change is then explained by Barsam *et al.* (2017).

The geotechnical risk of the new tunnels and underground stations was subject to extensive early work to understand the geology of the London basin and how to manage risks during construction. Complex ground conditions, water, obstructions, excavation-induced ground settlement and even unexploded ordnance were among the risks assessed through extensive ground investigations, testing and monitoring. Black (2017) describes how this essential work allowed hazards to be managed throughout the project.

Construction of the new underground structures – the majority being delivered by tunnel-boring machines and sprayed concrete lining techniques – is then explained in papers by King *et al.* (2017), Coughlan *et al.* (2017) and St John *et al.* (2017). The project built on proven technology, creating safe ways of working to deliver larger underground spaces than ever constructed before and

invested in extensive ground management techniques to minimise and manage settlement. These learnings build upon the history of tunnel construction and identify considerations for future projects building below ground.

Finally, the scale of the project and its extensive supply chain meant safe management of hundreds of thousands of vehicles serving work sites was vital. Coupled with the project's 'target zero' approach to safety, the strategy sought to manage logistics safely not only in work sites but beyond on the road network. The effective management of vehicles, training and reporting established by the project has set a new standard in the industry and is detailed in our final paper by Fraser *et al.* (2017).

A further special issue of *Civil Engineering* on Crossrail project management topics is being published in November 2017. More papers on design and construction can be found in the three volumes of *Crossrail Project: Infrastructure Design and Construction* published by ICE Publishing (Black *et al.*, 2015), in numerous other ICE *Proceedings* papers and at learninglegacy.crossrail.co.uk.

References

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