

Annulus Grouting and Leak Sealing of Tunnels

Glasgow Subway

Client

Strathclyde Partnership for Transport (SPT)

Principal Contractor

Freyssinet Ltd

Principal Designer

Freyssinet Ltd

Contract Value

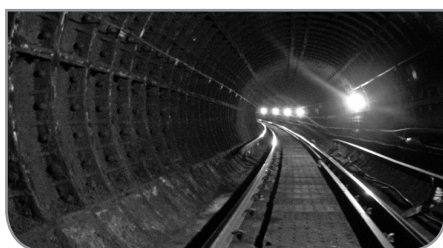
£22 million

Contract Duration

22 months

Work Commenced

April 2015



The Glasgow Subway is an underground railway dating from 1896, making it the third oldest underground railway in the world, after London and Istanbul. It comprises of two tunnels, a clockwise Outer Circle and an anti-clockwise Inner Circle, each 10km long and is used by over 40,000 passengers everyday.

SPT's Glasgow Subway modernisation scheme is the underground's first full-scale upgrade in more than 30 years.

Freyssinet executed works including annulus grouting, cleaning of the tunnel lining, track bed and drainage channel, concrete and brickwork lining repairs and resin injection leak-sealing over a total of 8,019 linear metres.

The bulk of the repairs took place in tunnels running between Hillhead and Buchanan Street stations in the city centre, a stretch which incorporates Kelvinbridge, St George's Cross and Cowcaddens stations. Freyssinet carried out improvements in a section of tunnels on the east side of Glasgow from Shields Road to Kinning Park. The works included:

- Cleaning of the tunnel lining, track bed, slip and drainage channel.
- Investigation and assessment of the condition of the lining, including removal of steel drip sheets.
- Recording of data onto ScanPrint tablet-based data management tool.
- Probe hole investigations to determine the thickness of the tunnel lining and the presence and extent of voids behind it. Approximately 5,500 number 50mm diameter probe holes are required.
- Design of the necessary repairs.
- Annulus grouting with cement grout, requiring approximately 3,000m³ of grout and 46,000 number 32mm diameter injection holes.
- Convergence monitoring between five reference points around the tunnel circumference to verify there is no unexpected movement of the lining during critical works.
- Concrete lining repair works comprising; hand-placed concrete patch repairs and up to 2,700m² of sprayed concrete repairs.
- Resin injection leak-sealing of brick and concrete linings requiring an estimated 18,000 injection holes and 68,000 litres of resin.
- Installation of weep pipes to manage ingress of water.
- Track bed repair works to seal cracks and prevent ingress of water and silts.

Additional works were carried out in a further 6,672 linear metres and included the cleaning of the lining, followed by investigation and assessment of its condition to allow the prioritisation of subsequent phases of work.

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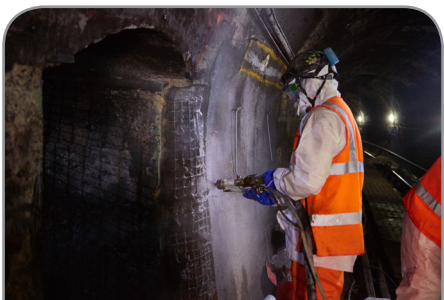
SPT wanted to avoid full-scale shut down of the tunnel, choosing to do the works during night-time closures from 00:30 to 05:00 over the contract period. The labour force averaged at about 80, but at the peak in operations, Freyssinet brought 130 people into the tunnels.

Due to the complex nature of the working environment, Freyssinet developed a number of innovative methods to ensure the safety of its employees, other subcontractors and the general public. These included an overhead conveyor, designed and installed with help from Amber Industries, which was used to transport grout materials into the tunnel and substantially reduced manual handling, plus various custom made lifting devices, bespoke working platforms mounted on track trolleys and a dust control system.

Freyssinet also developed a bespoke drilling rig in conjunction with Sept Tools, which reduced the amount of working at height required and exposure to harmful levels of vibration, and an innovative miniaturized concrete spray solution combining dry and wet spray techniques to carry out structural repairs.

Freyssinet has subsequently won multiple awards for the project, including the prestigious Lord Cullen Trophy for Safety Performance at the annual Scottish Chamber of Safety Awards. The trophy, given in recognition of an outstanding contribution to improving health, safety and environmental issues, was awarded to Freyssinet in acknowledgement of its commitment and innovative approach to health and safety on Glasgow Subway improvement scheme.

Freyssinet was also awarded the Infrastructure Innovation Commendation at the ICE Saltire Civil Engineering Awards, which celebrates outstanding engineering achievements in Scotland.



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