# INNOVATION - KNOWLEDGE SHARING

FERROVIAL AGROMAN
LAING O'ROURKE JV

## Project: Northern Line Extension – Kennington

### KENNINGTON TUNNELS AND STEP PLATE JUNCTION

# TUNNEL PLUGS

## Background:

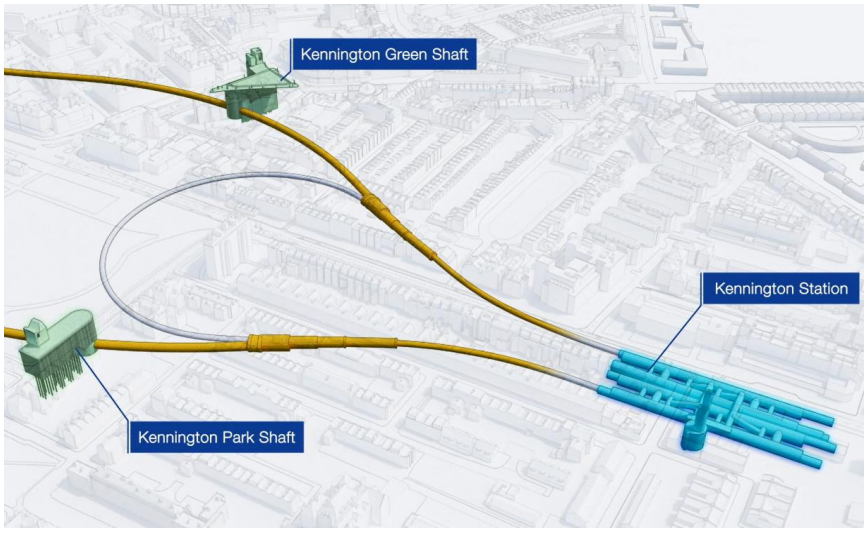
As part of the works to connect the new running tunnels and the step plate junction to the existing tube network Ferrovial Agroman Laing O'Rourke JV (FLO) had to remove the existing tunnel rings which were built in 1926.

To facilitate this requirement a section of track within the Kennington Loop was closed for one weekend.

FLO endeavoured to keep the tube network running throughout the weekend works on the Bank and the Charing Cross branch of the Northern Line so as to create minimal disruption to the travelling public.

The section of track and tunnel which was closed was very close to Kennington station platforms and also very close to the tracks where trains were running at normal speed.

The tunnel rings which were being removed were encased in grout on the outside face and contained 90 years worth of dirt, soot and brake dust on the inside.




## Problem:

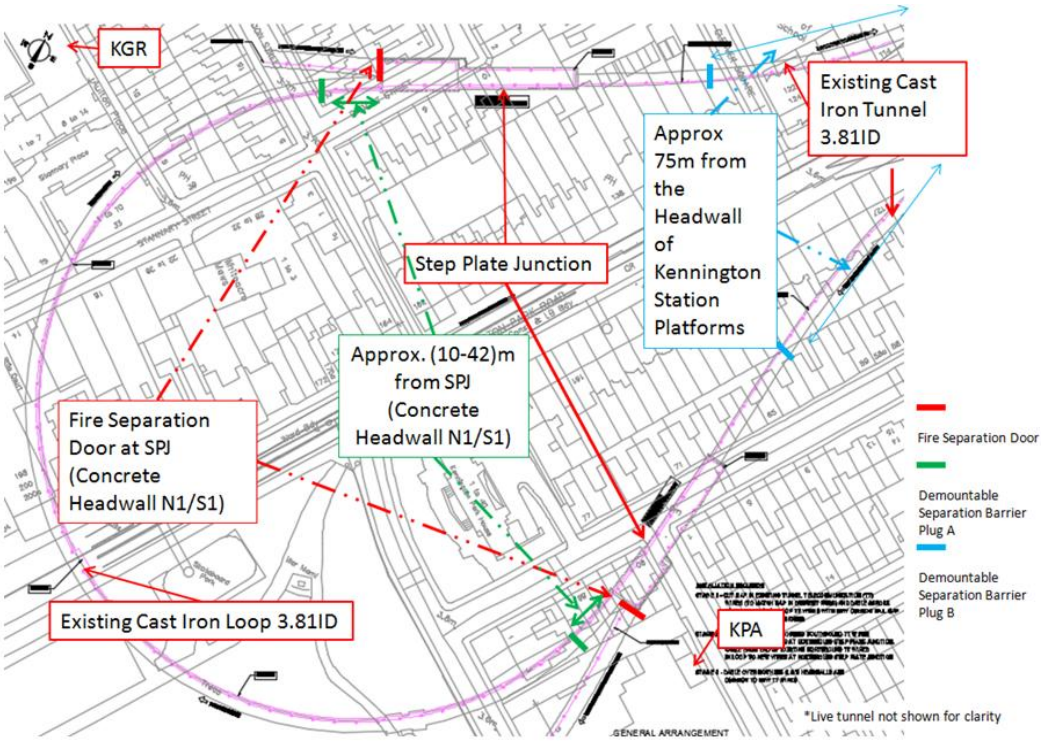
The construction team immediately realised the health hazards that were present, suitable control measures such as water suppression and personal protective equipment - personal face fitted masks and breathing apparatus could be issued to the workforce to ensure they were not put at risk of exposure to harmful dusts during the works.

The challenge the team faced however was preventing dust and debris from the works being transferred through the tunnels and into the live tube network and nearby station when trains were operating.

The piston effect of a train running through a tube tunnel causes the airflow in adjacent tunnels to accelerate and creates a pushing and suction effect generating large air pressure differentials.

This was also the first time that this work had been undertaken when the remainder of the tube network was still operational and open to the public.

This was the engineering challenge the team faced.




## Key Criteria:

The required solution had to meet a number of key criteria .

- It must provide a barrier to dust and fire to separate the works from the live underground network.

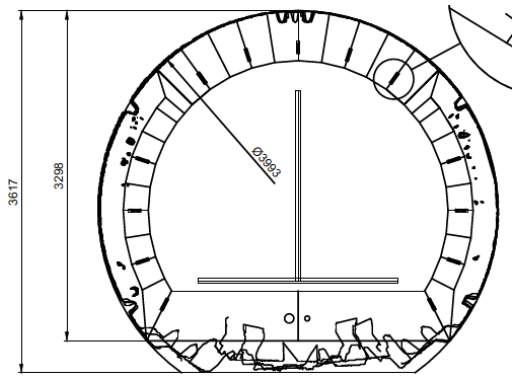
- It must be easy to install during the 45minute window assigned to `take the possession`

- All materials must be fire retardant and comply with London Underground safety standards

- Could be easily fixed to the existing tunnel rings

## Solution:

The FLO engineers used 3D scanning and imaging to survey the exact shape of the old tunnel and locate the cables and brackets which were on the inside of the tunnel.




TUNNEL PLUG
SHOWN WITH TUNNEL SCAN DATA

The team developed the tunnel plug to fill the void in the existing tunnel and create a barrier between the worksite and the existing underground network and nearby platforms.

The design fully complied with all of the criteria and a CAT3 design check was certified prior to installation on the live network.

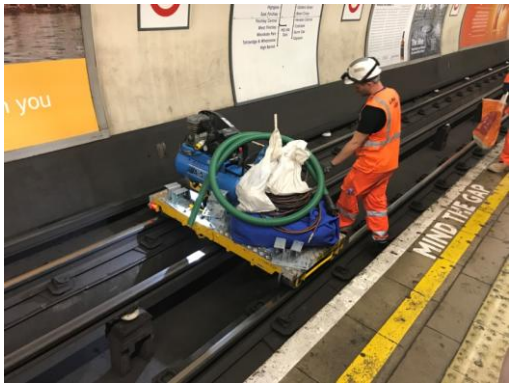
The tunnel plug was manufactured from a medium weight fibre glass fabric with a specially formulated aluminium pigmented and fire retardant polyurethane.
The tunnel plug incorporated covers to the zips and a seal to the tunnel lining which prevented dust passing and provided a fire rated barrier.

The fixings between the tunnel plug and the tunnel lining were developed to allow the tunnel plug to move as the air pressure changed on the each side without compromising the dust / fire seal.

The completed tunnel plug was light enough to be lifted and installed by 2 persons.
It could be transferred to track trolleys quickly and installed with ease to the fixings which were pre-installed in the tunnel lining.

The tunnel plug was installed and inflated in 20mins on the night of the works.

All of the materials complied with London Underground standards for fire safety of materials.



## Reasons for success:

- The FLO team and their subcontractor 4Rail worked collaboratively to create the product. Team work was key to this innovative solution.

- A prototype was manufactured 10 weeks prior to the possession and was trialled during night shifts when trains were not running to ensure the fit with the existing tunnel was correct and that the information obtained during the 3D scanning was correctly applied to the manufacturing process.

- The team undertook trial installs to time how long it would take to move and install the tunnel plugs.

- A monitor and compressor were fitted to the tunnel plugs during the weekend works to ensure the air pressure was maintained. This system could automatically `top` up the air inside the plug as required to ensure the seal was not compromised.