

More detail on repairs and maintenance work on the tunnel between 2015-2019 is given in the addendum below.

ADDENDUM

KAIMAI UPDATE 45 YEARS ON: 2015-2019 REPAIRS AND MAINTENANCE

General Condition

Forty plus years after it opened, deterioration of the base slab in the drill and blast 'horseshoe' part of the tunnel had occurred due to ground water leaching fines from below the base slab and compromising support of the track slab (PaCT)*. A small portion of the PaCT slab had become damaged due to failure of the base slab support. The original cork pad beneath the rails had deteriorated over time and been replaced with discrete pads in some areas. In some places the rails had deflected to contact the slab top and a groove had been formed by rail movement during the passage of trains. A number of spheroidal graphite Pandrol™ rail clip shoulders locating the rails were showing significant corrosion and required replacement. The combined effect of these problems had caused deterioration of the original track geometry.

Ground-water management required attention as many of the original weepholes were blocked with debris. Some of the steel supports for the central drain had corroded badly and the trackside drain timber covers that also provide a crew walkway for drivers needing to exit a train were substandard in condition. Areas of the horseshoe section had developed higher groundwater flows including thermal waters and grouting treatment was desirable to reduce these. The central drain was functioning well.

Concrete cores taken from the base slab and PaCT slab in the horseshoe tunnel areas showed there was no carbonation or chloride deterioration of the concrete, nor were there any signs of alkali-silica reaction and the interface between the PaCT slab and the base slab was found to be sound.

PaCT and Base Slab Repairs

Locally, a small, damaged section of the PaCT slab was renewed to the original design. A specially designed resin concrete was used to reduce setting times in order to minimise tunnel shutdown times. In three locations levelling grout was pumped under the base slab to lift the rails back to their design position. Specialist resin grout was then used along the horseshoe section to fill the voids beneath the base slab.

Concrete coring was undertaken to verify that the voids had been completely filled.

Rail contact damage to the PaCT slab was repaired with another specialist rapid curing grout, so that trains could run immediately after track hand back.

Water Ingress Management

Ground water ingress had increased into to the tunnel, some of which at one or two locations was warm from the geothermal source. Grouting behind the lining has been carried out to reduce and reroute flows.

The timber covers on the side drains within the tunnel are being fully renewed.

Many of the original weepholes are quite blocked with debris. New ones have been drilled to direct ground water into the tunnel drainage systems.

A drain interceptor unit has been installed outside of the tunnel to capture any contamination/ debris contained in the tunnel outflows.

Rail and Fastenings

The original cork continuous pad under the rails has been reinstated using a continuous rubber pad.

Approximately 800 Pandrol fastener shoulders grouted into the PaCT slab were replaced, primarily because of corrosion issues.

Ten joints in the existing rails were welded in order to form Continuous Welded Rail throughout the tunnel.

Tunnel Services

A new leaky feeder system was installed to provide robust radio communications throughout the tunnel.

Structural Analysis of PaCT Slab

A finite element numerical analysis was undertaken of the PaCT and base slabs which indicated that under the assumed increases in axle loads, train speeds and frequency of trains the system will be able to service the predicted rail traffic for at least the next 20 years provided that regular inspections, monitoring and maintenance is undertaken.

**The PaCT slab is a slip formed reinforced concrete slab constructed over the tunnel floor using a patented machine system developed by British Rail and McGregor paving in the UK. It enables the rails to be directly fastened to the slab eliminating the need for sleepers and ballast.*

J F Webley, 19 March 2022