

# Rail and Underground Panel



Date: 16 July 2015

Item: Jubilee Line Tunnel Works

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## This paper will be considered in public

### 1 Summary

- 1.1 The accompanying presentation provides an update on the Jubilee line tunnel works which have replaced concrete tunnel segments on a section of the line between Bond Street and Baker Street.
- 1.2 The presentation describes:
- (a) the deterioration of the tunnel lining;
  - (b) how this was initially managed and investigated;
  - (c) the trial undertaken at Charing Cross to test a solution and the project which was established to replace the concrete lining with iron segments;
  - (d) the outcome of the project which is substantially completed; and
  - (e) how the lessons learnt from this project will be utilised on other similar projects.

### 2 Recommendation

- 2.1 **The Panel is asked to note the paper and presentation.**

#### List of appendices

Appendix 1: Presentation on Jubilee line tunnel works

#### List of background papers

None

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# **Jubilee Line Tunnel Works (Baker Street to Bond Street)**



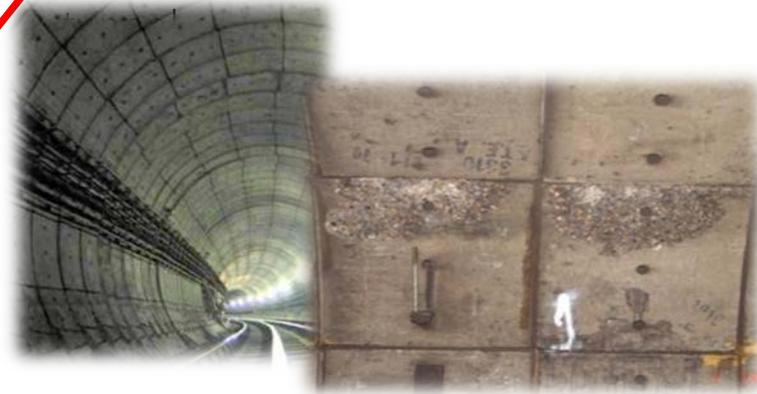
# Background (2000 – 2015)



Acid groundwater attacking structure



“BS BS” Baker Street to Bond Street deterioration of 200 metres of concrete lined



“SOBS” South of Bond Street sand and water ingress

Bond Street station, current water ingress

Central

Crossrail



## History

- Defects first noted in 2000
- Progressive deterioration since (spalling/cracking)
- Deformation of structure

## Response

- Managed by London Underground (LU)/Tube Lines (TL) panel to ensure risk is As Low As Reasonably Practicable (ALARP)
- Extensive LU investigations (identified complex issues including ground conditions)
- Local repairs (initially)
- Comprehensive temporary support before London 2012
- **Decision to reconstruct**





## Charing Cross trial (2010)

- Tested feasibility of replacing segments in engineering hours
- Tested manually operated prototype plant

**Conclusion – qualified success** (The lining could be replaced in engineering hours but an improved system was needed)

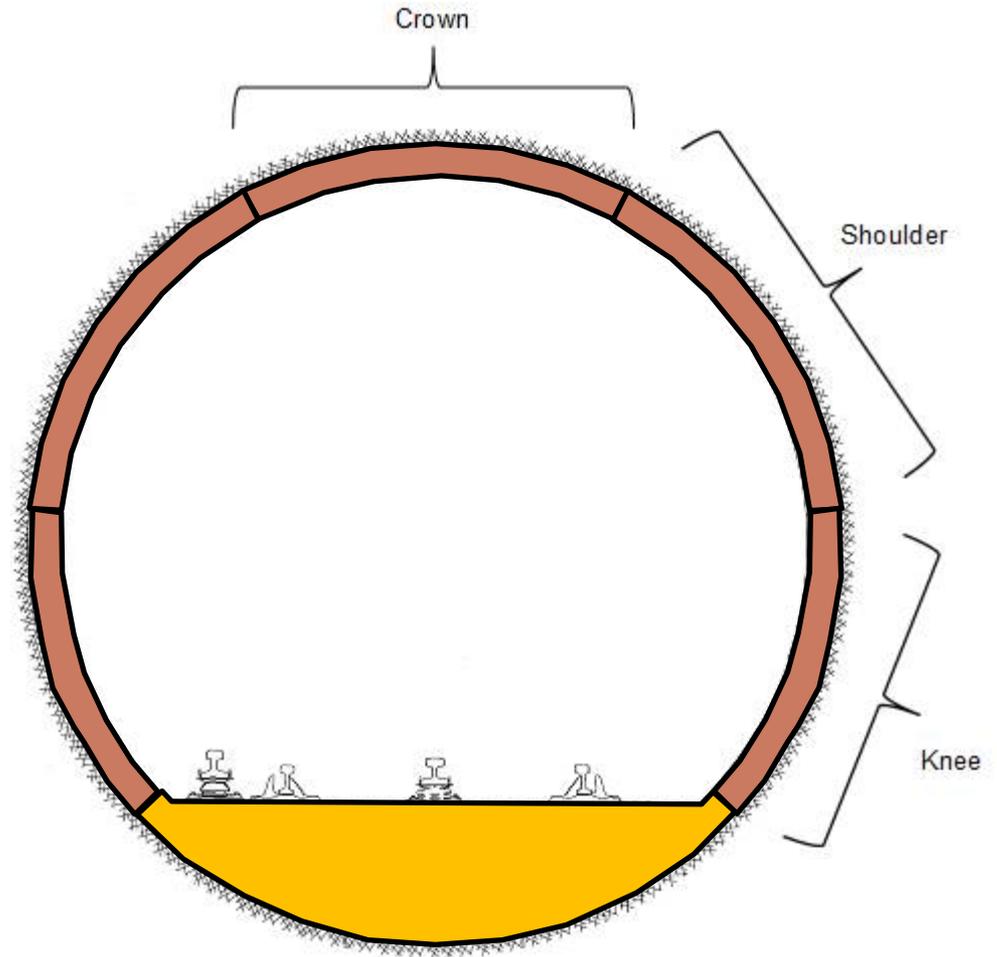


# Main works design

17 concrete segments above the track replaced with 5 new iron segments

5 concrete segments below the track remain and the invert is strengthened

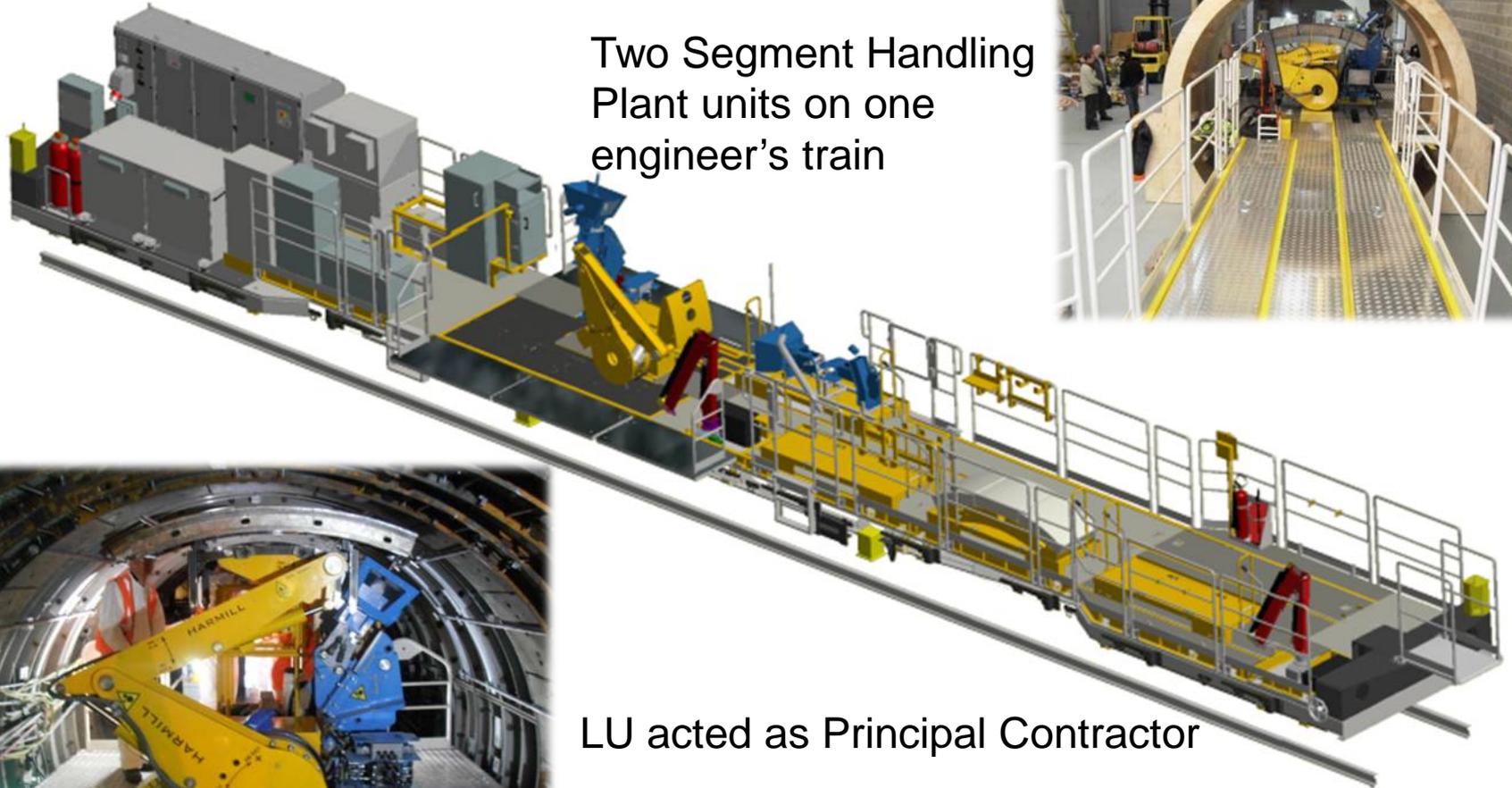
Designed in-house



# Unique “Segment Handling Plant” design



Two Segment Handling Plant units on one engineer's train

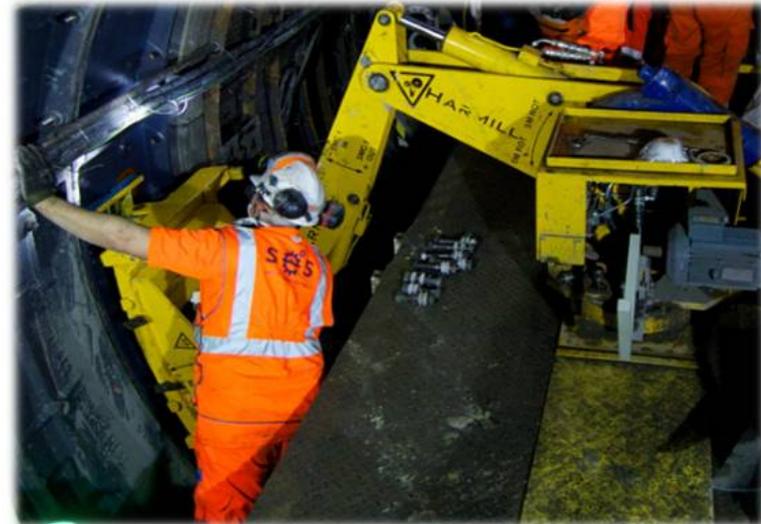


LU acted as Principal Contractor

ROGS Independent Safety Verification applied

Liaison with ORR





# Collaboration

Efficient production has required close collaboration across the business and input from various departments. All have worked to improve opportunities for access and to optimise the working time at the site.

- Jubilee line management team
- Access and Planning
- Track patrols
- Maintenance
- Project teams at Bond Street Station Upgrade and Baker Street

Cross project cooperation has maximised the opportunities to share closures



# Access

The actual works used a combination of engineering hours and closures. Some of the closures were opportunities shared with other works.

Access type used	Number of shifts
Engineering Hours shifts	461
Late start Sunday closures	25
27 hour closures	7
52 hour closures	6
4 day (Easter) closures	2
6 day (Christmas) closures	2



## Positive outcomes

Segment replacement commenced 16 June 2013 and **completed June 2015**

Post-relining works will be completed by November 2015

Tunnel will then have **full asset life expectancy** without exceptional maintenance

Benefits outside the London area –

- SGI casting (Scunthorpe & Preston)
- SGI machining (Manchester)
- Segment Handling Plant manufacturer (Leighton Buzzard)
- Relining labour sub-contractor (Doncaster)



# Safety

- Exceptional safety record
- One Lost Time Injury, due to defective equipment
- Safety Innovations - Proximity Alarm System (PAS) and FHOSS illuminated hives

# Financial/Programme

- EFC £32.87m (incl. £0.34m of risk) vs Authority £34.4m
- Tunnel relining substantial completion before the end of June against baseline 31 October 2015



# Lessons Learned

- The original diagnosis of the problem was correct.
- Tunnel risk has been maintained ALARP throughout. Risk in the relined section is now reduced to “normal tunnel” level. Special measures remain in place to keep other sections (eg the acid affected tunnel) at ALARP risk.
- The underlying geotechnical issues are now better understood. Knowledge has been shared with planned LU projects, Crossrail, HS1, British Geological Survey and others
- Undertaking trial works greatly improved the “production” design
- Engineering hours efficiency: close collaboration across the business optimised the working window
- Early engagement of the ORR provided expert advice and support
- ROGS Independent Safety Verification contributed to development of LU’s Independent Safety Verification tool



## Lessons learnt - access

Data collected during the work permits modelling of how long the work would probably have taken with other access strategies

Access scenario	Duration (relining only)	Disruption	Lost customer hours (LCH)	Estimated cost (EFC excl. risk)
Engineering Hours only	3.5yrs	No network disruption but increased risk due to extended duration	n/a	£43.6m
Weekends only (52 hours)	36 weeks	Closure of Jubilee line (Finchley Road to Waterloo) for 36 weekends	6,699,348	£23.1m
Blockade	16 weeks	Closure of Jubilee line (Stanmore to Waterloo) for 16 weeks	38,733,345	£23.5m
Actual	2 years	The project maximised the use of other closures on the line to reduce the impact of the work	4,933,089	£32.9m



## The future

The rebuilt section has a full asset life expectancy without exceptional maintenance.

Other, less severe, geotechnical issues persist in the tunnels of the Bond Street area. Further works are planned:

- Grouting to prevent acid attack in running tunnels (June to October 2015)
- Control of water ingress to Jubilee platform areas.

LU is feeding knowledge gained to other TfL projects involving similar ground (eg Northern Line Extension (NLE), Crossrail 2). We are also discussing knowledge sharing proposals with the wider industry.

The skills and plant developed on the project may present an opportunity for future works (eg NLE step plate dismantling, Piccadilly line clearance improvement).

