



Parapet Study and LOI 331

Why?

- Due to the withdrawal of Railway Group Standards and the introduction of TSIs for the energy sub-system (invoking the use of BS EN 50122), a misalignment of technical requirements for parapets on structures above railway overhead electrical equipment occurred over time.
- Highlighted on NWEF
- Holistic risk management related to bridge parapet heights

Introduction

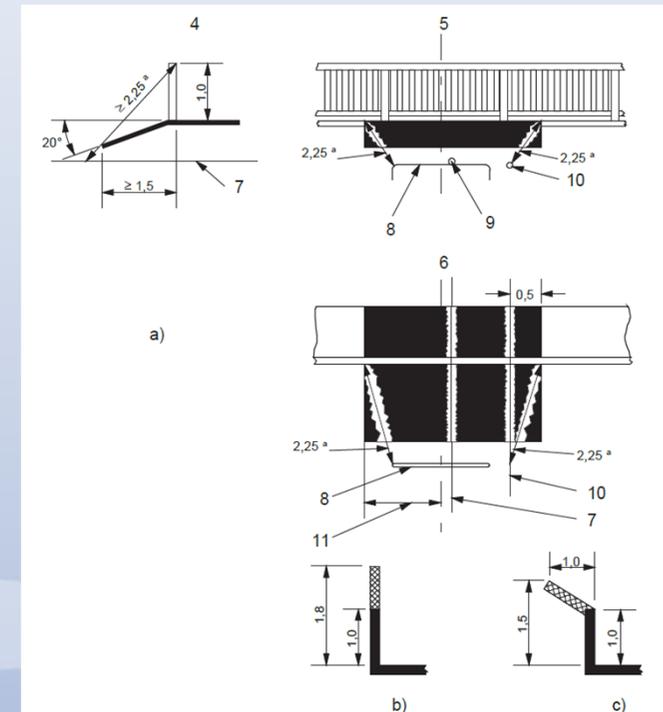
- Background
- Parapet Risk Study
- Proposed changes to NR/L3/CIV/020
- Discussion

Background – the issues

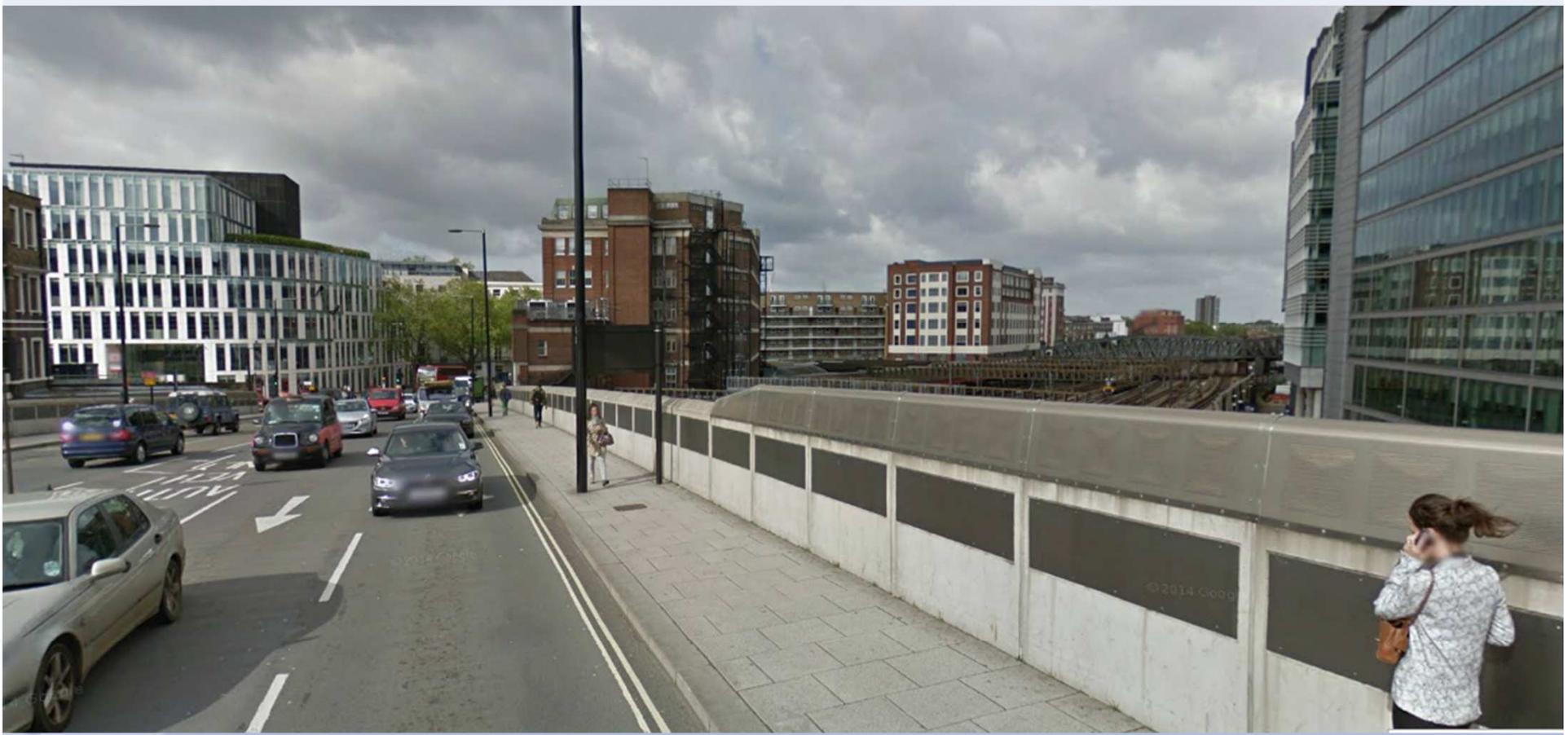
- Risks need to be eliminated or reduced SFAIRP
 - Health & Safety at Work Act
 - Railway Safety (Miscellaneous Provisions) Regulations (1997)
 - Electricity at Work Regulations
 - (*Construction (Design and Management) Regulations*)
- General bridge design practice
 - Public behaviour risk often not sufficiently understood / considered in design
 - Electrical risk and requirements often not sufficiently understood
 - Designers tend to adopt minimum requirements in standards

Background – the issues

- BS EN 50122-1
 - Open to interpretation
 - 2 of 3 specified examples not considered appropriate for UK
 - Not clear if equivalent alternatives are permitted
 - Possibly non-compliant with EWR
 - Update unlikely before 2017
- Risks not being reduced SFAIRP in all cases



Parapet Risk Study

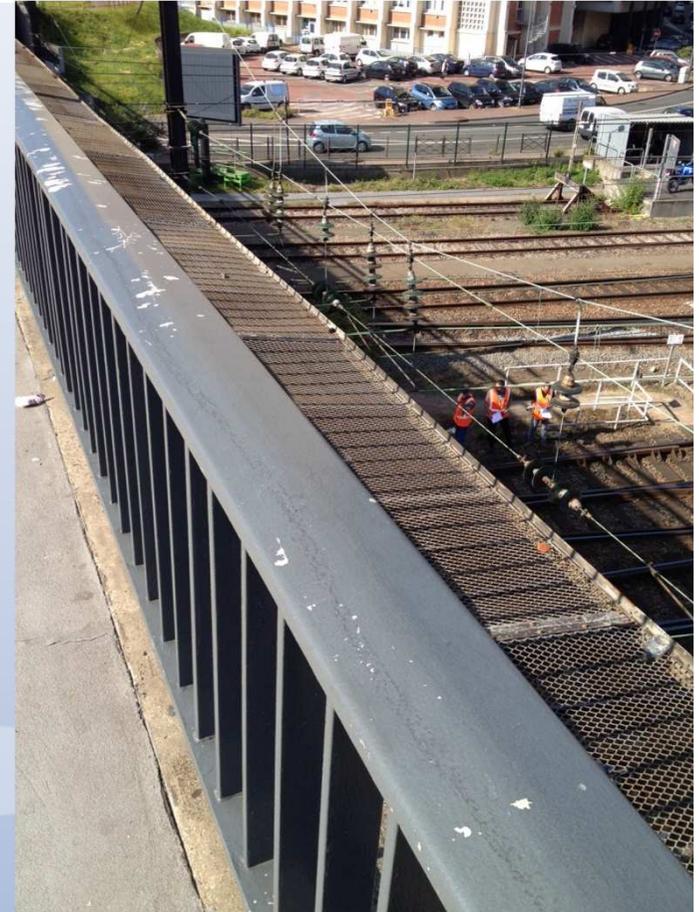


**Committed
to Safety**


Mott MacDonald

Parapet Risk Study – Purpose

- To undertake holistic review of parapet design and risk mitigation
- To review current standards, notably BS EN 50122:1
- To update NR/L3/CIV/020

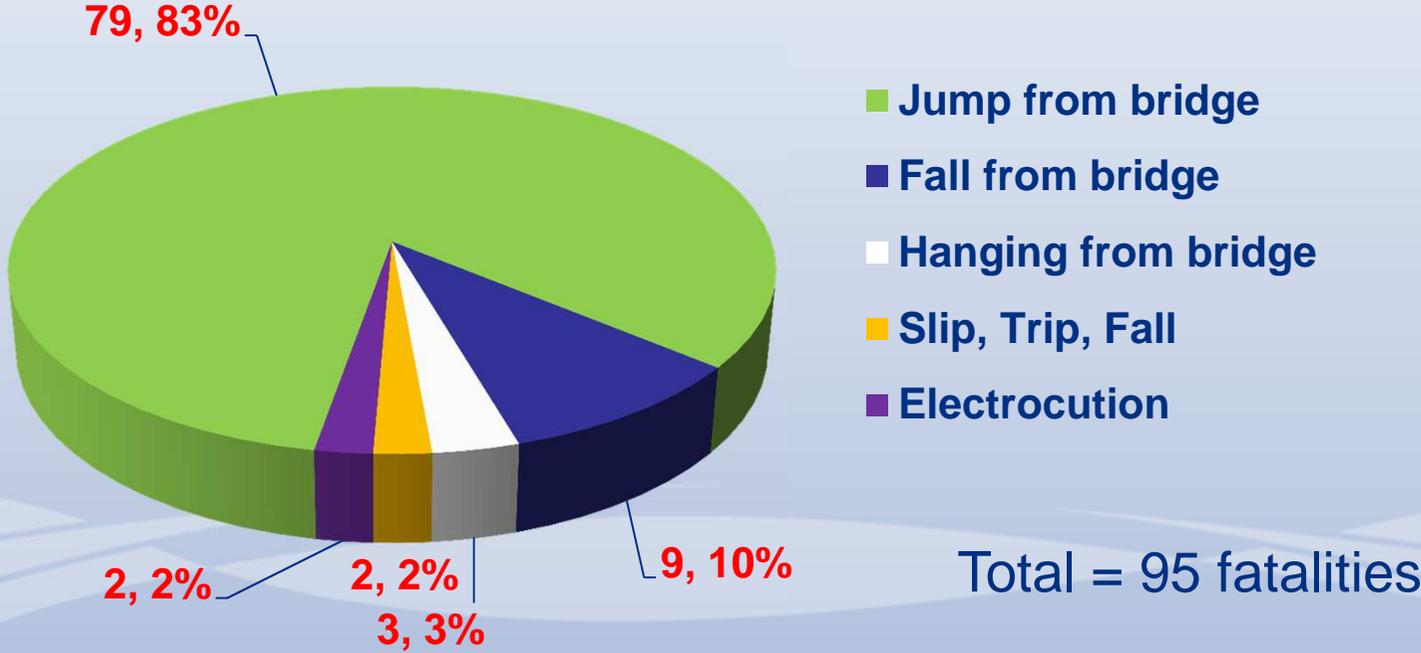


Parapet Risk Study – Method

- Risk assessment followed Common Safety Method
 1. Application of Codes of Practice – n/a
 2. Comparison with reference systems – n/a
 3. **Explicit risk estimation**
- Qualitative risk assessment
- Statistical data review
- Quantitative risk assessment & CBA

Parapet Risk Study - 10yr Fatality Data

Identifiable breakdown of bridge related
passenger & public fatalities over 10yr period



Parapet Risk Study

– Parapet related risk

Category	Parapet related risk FWI/yr	% of Parapet related risk
Suicide	9.80	72%
Fall off structure	2.61	19%
Struck by train (trespass via parapet)	0.71	5%
Electrocution	0.35	3%
Slip/trip/fall	0.04	0.3%
Object thrown/fired at train	0.01	0.1%
Worker crushed (RTA)	0.01	0.1%
Object dropped/placed on line	0.004	0.03%
Debris falling from parapet	0.001	0.01%
Total parapet related	13.5	100%
Structural failure	0.13	1%
Embankment/cutting failure	0.41	3%
Total Railway Risk	376	

Risk associated with bridge parapets as % of all railway risk = **3.6%**

Parapet Risk Study - QRA / CBA

- NR CBA Tool v8
 - SRM based assessment
- Key Input Data
 - 14,899 overline bridges & footbridges
 - £5,000 extra / bridge (new)
 - £50,000 for parapet height upgrade
- Key Risk Assumptions (1.8m parapet)
 - 10% reduction in suicide (baseline)
 - 50% reduction in falls

Calculation of costs and benefits associated with a safety enhancement

Assessor	Simon Ellis, Mott MacDonald
date	29/04/2018
Name of location being considered	100 typical (average) NEW BRIDGES
Describe the upgrade being considered	UPGRADING HEIGHT OF PARAPET from 1.5 to 1.8m
What is the cost of the proposed scheme/upgrade? (Enter amount in pounds)	£500,000
Current Grip Stage	4
What is the increase to Maintenance costs per year? (Enter amount in pounds; put a decrease as negative)	£0
What is the increase to Operational costs per year? (Enter amount in pounds; put a decrease as negative)	-£3,500
Annual Avoided Cost of Incidents	
Life of upgrade (years)	60
Source of data for assessment	SRM
VPF (see H&SMS for current figure)	£1,826,000

Assumptions

General

- 14,899 bridge structures on network
- £5,000 construction cost per structure (average)
- 60 year life
- Current Grip Stage = 4 (although not at Grip Stage 4, increased confidence as considering average costs, rather than site specific costs).

Suicide

- 4% of suicides either off bridges or from inside via bridge parapet. Risk reduction = 10%.

Accidental falls from bridges

- 50% reduction in accidental falls resulting from increasing parapet height.

Electric Shock - OLE

- 30% of public and passenger (excl trespass related) risk related to bridges. Risk reduction = 50%.
- 10% of Workforce risk related to bridges. Risk reduction = 50%.

Trespass risk

- 30% of risk of electric shock from OLE related to bridge parapets. Risk reduction = 50%
- 5% of risk outside stations due to strike with train or contact with conductor rail, related to access via bridge parapets. No change in risk.
- 50% reduction in risk of falls/jumps from bridges.
- 0% of risk inside stations due to strike with train or contact with conductor rail related to access via bridge parapets. No change in risk.
- 5% of risk of slip, trip or falls on railway infrastructure (excl falls from bridges), related to access via bridge parapets. Risk reduction = 10%

Vandalism

- 20% of objects thrown/fired at trains are from bridges. Risk reduction = 50%
- 10% of objects on the line (either from thrown over parapet or from vandal access via bridge parapets). Risk reduction = 25%.

Road Interface

- 5% of risk of infrastructure workers struck/crushed by non-train vehicle related to bridge parapets. No change in risk.
- 1% of risk of vehicle on the inside following RTA, related to bridge parapet (height). Risk increase = 100%.

Structural Condition

- 5% of risk of structural collapse or debris from overbridges, related to bridge parapets. No change in risk.

Results

Safety Risk reduction (FWI per year)	0.016964442
Benefit-Cost Ratio including O&M changes	1.87
Equivalent Benefit with O&M costs (allowing for optimism bias & financing cost)	£933,687
Benefit-Cost Ratio without O&M costs	1.74
Equivalent Benefit without O&M costs	£871,997
Annual safety benefit for OPEX-only mitigations	£30,977

Identified Secondary Matrix Risk

Stakeholder	change in risk as percentage of initial risk
Stakeholder	-58%
Service user experience	-77%
Value finance	0%
Environment	0%
Process	0%
People- Employee Engagement	0%

8.0 <= CBA tool version
Notes for use:

- Enter the information required in the yellow cells above - MAKE SURE CELL C25 HAS THE RIGHT CHOICE
- Click onto the relevant sheet in the tabs below for the type of assessment and enter the information.
- Read the results in the blue box above; the first ratio includes all costs & benefits; the second shows the safety
- The CBA sheet shows the detailed results of the cost benefit calculation.
- The annual safety benefit figure is only to be used for input to simple payback assessments or for mitigations with no CAPEX cost; full CBAs should use the B-C Ratio figures.
- The grey results box shows the risk change (negative denotes an improvement) as a percentage of the initial risk for secondary non safety risks identified using the Corporate Risk matrix.

Cost Benefits analysis

Legend: ■ risk reduction, ■ risk increase

Parapet Risk Study - QRA / CBA Results

Risk category	Risk breakdown related to bridge parapets	Safety benefit breakdown
Trespass	24.8%	54.2%
Suicide	72.4%	38.8%
Accident	2.6%	6.7%
Vandalism	0.1%	0.3%
Bridge debris	0.0%	0.0%
Grand Total (%)	100%	100%
Grand Total (FWI/yr)	13.5	2.5

Benefit to Cost Ratio
(Baseline case)

New build = 1.9 ✓

Retrofit = 0.2 ✗

✓ (>1.0) Benefits likely to outweigh costs

✗ (<0.5) Cost likely to be grossly disproportionate to safety benefit

Parapet Risk Study - Population breakdown

- Breakdown of overbridge population

		Electrification	Over non-electrified lines		Over OLE		Over 3rd Rail	
		%	61%		23%		16%	
Height	Height above tracks		< 10m	≥ 10m	< 10m	≥ 10m	< 10m	≥ 10m
		Standing surface > 10m above	15%	52%	9%	20%	3%	14%
Location	T&V Hotspot	5%	3%	0%	1%	0%	1%	0%
	Other built-up area	45%	23%	4%	9%	2%	6%	1%
	Rural area	50%	26%	5%	10%	2%	7%	1%

Parapet Risk Study - QRA / CBA Results

- New Build Benefit-Cost ratios
 - Average across population = 1.89

NEW BUILD £5000 per structure	Cost Benefit Ratio (incl O&M)	Location (T&V Risk)	Electrification	Over non-electified lines		Over OLE		Over 3rd Rail	
			Height above tracks	< 10m	≥ 10m	< 10m	≥ 10m	< 10m	≥ 10m
		T&V Hotspot	✓ 4.8	✓ 11.4	✓ 6.9	✓ 7.5	✓ 4.9	✓ 11.5	
Other built-up area	✓ 2.1	✓ 7.3	✓ 2.8	✓ 4.2	✓ 2.2	✓ 7.3			
Rural area	✗ 0.3	✓ 1.7	✗ 0.4	! 0.9	✗ 0.3	✓ 1.7			

- ✓ Benefits likely to outweigh costs
- ! Further consideration (of gross disproportionality) required
- ✗ Cost likely to be grossly disproportionate to safety benefit

QRA/CBA

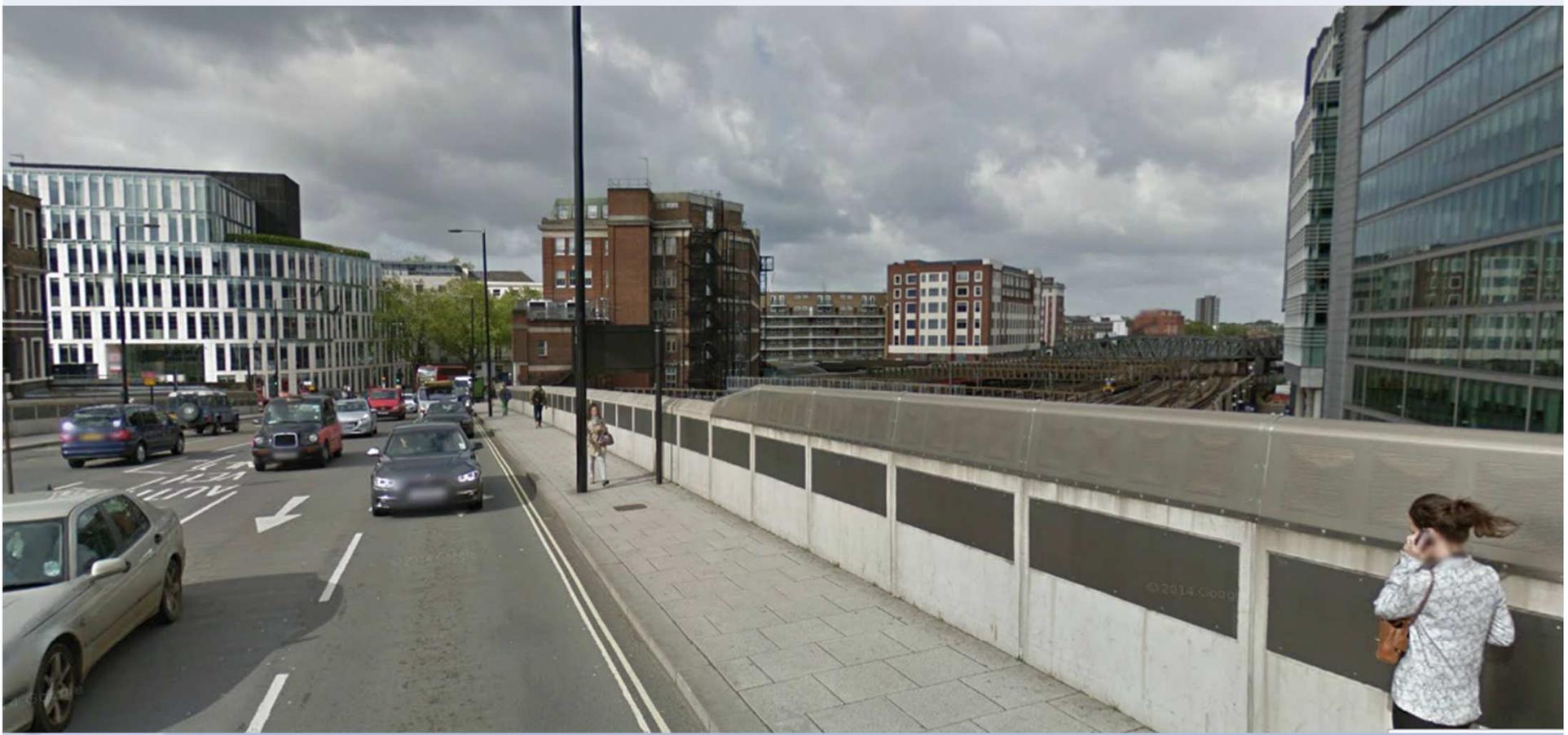
- QRA Results

- Retrofit Benefit-Cost ratios
 - Average across population = 0.19

RETROFIT £50000 per structure (assumes same risk profile as new build)	Cost Benefit Ratio (incl O&M)	Electrification	Over non-electified lines		Over OLE		Over 3rd Rail		
			Location (T&V Risk)	Height above tracks	< 10m	≥ 10m	< 10m	≥ 10m	< 10m
		T&V Hotspot			✗ 0.5	✓ 1.1	! 0.7	! 0.8	✗ 0.5
Other built-up area			✗ 0.2	! 0.7	✗ 0.3	✗ 0.4	✗ 0.2	! 0.7	
Rural area			✗ 0.0	✗ 0.2	✗ 0.0	✗ 0.1	✗ 0.0	✗ 0.2	

- ✓ Benefits likely to outweigh costs
- ! Further consideration (of gross disproportionality) required
- ✗ Cost likely to be grossly disproportionate to safety benefit

Proposed changes to NR/L3/CIV/020



**Committed
to Safety**


Mott MacDonald

Proposed changes to NR/L3/CIV/020

- Increase in minimum height of new parapets over railway
 - Non-motorway overbridges 1.5m → **1.8m***
 - Motorway overbridges 1.5m (n/c)
 - Footbridges 1.5m → **1.8m***
 - Intersection bridges 1.25m (1.5m over OLE) (n/c)
 - Any bridge at high risk of T&V / suicide **1.8m**

** may be reduced to 1.5m in low risk locations*

Proposed changes to NR/L3/CIV/020

- Requirements for new or existing parapets over new or upgraded OLE:
 - where protection provided by clearance
 - Protection by clearance envelope (solid decks) 3.0m → **2.25m**
 - Motorway bridges considered as 'public area' **clarification**
 - where protection provided by obstacle
 - Protection by lateral obstacle **departure required**
 - Overbridges / footbridges over OLE 1.8m (n/c)
 - Underline / intersection bridge over OLE 1.5m (n/c)
 - All bridges where OLE adjacent to parapet 1.8m (n/c)
 - Lateral clearances where OLE adjacent to parapet **some increases**

Proposed changes to NR/L3/CIV/020

- SFAIRP requirements highlighted
- Additional guidance on
 - Parapet risks
 - Structure upgrades
 - Protective provisions over/adjacent to OLE
- Details of electrical protection, earthing and bonding to be provided in AiP (Form F001 & F002) submissions
- Passive provision for future OLE in new/renewed structures
- Electricity hazard signs to be installed on bridges over OLE (tbc)

Implementation of LOI 331

The Letter of Instruction applies to:

- a) all schemes introducing a new energy sub-system;
- b) all schemes introducing upgrades or renewals of existing energy sub-systems, where renewal and upgrade is as defined in the Railway (Interoperability) Regulations 2011;
- c) all bridges that are renewed, up-graded or newly installed;
- d) all outside party bridge schemes yet to commence detailed design.

Implementation of LOI 331

- With the exception of installation or replacement of fencing or parapet mesh infill/extensions, minor works or non-structural repairs are not subject to the Letter of Instruction.
- The Letter of Instruction shall be complied with by Network Rail and its Contractors from the 7th August 2015.

Implementation of LOI331

- It is permissible for projects that have formally completed GRIP Stage 3 (Option Selection) to continue to comply with the issue of any relevant Network Rail and Railway Group Standards current when GRIP Stage 3 was completed (unless the designated Standard Owner has stipulated otherwise in the accompanying Briefing Note) and not to comply with the new requirements with the exception of schemes subject to authorisation under the Interoperability Regulations.
- Applicable schemes (or parts thereof) that are yet to be authorised under the Railway (Interoperability) Regulations are to retrospectively comply with the Letter of Instruction.