



Guidance on the Management of Embedded and Grooved Rail Breaks


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THIS DOCUMENT PROVIDES GUIDANCE ON THE MANAGEMENT OF EMBEDDED AND GROOVED RAIL BREAKS WHILST MAINTAINING OPERATION OF A LIGHT RAIL SYSTEM.					
EXPLANATORY NOTE:					
The Light Rail Safety Standards Board is not a regulatory body and compliance with Guidance Notes or Approved Codes of Practice is not mandatory; they reflect good practice and are advisory only. Users are recommended to evaluate the guidance against their own arrangements in a structured and systematic way, noting that parts of the guidance may not be appropriate to their operations. It is recommended that this process of evaluation and any subsequent decision to adopt (or not adopt) elements of the guidance should be documented. Compliance with any or all the contents herein, is entirely at an organisation’s own discretion.					
SOURCE / RELATED DOCUMENTS:					
LRG 1.0 Tramway Principles and Guidance (TPG) (LRSSB) Report_90_3A_issue_1: Determination of Tramway Wheel and Rail Profiles to Minimise Derailment (ORR) Report_90_3B_issue_1: A Good Practice Guide for Managing the Wheel-Rail Interface of Light Rail and Tramway Systems (ORR) RT/CE/S/O57 Issue 4: Rail Failure Handbook (Network Rail) BS EN 16771:2016: Railway Applications Infrastructure Aluminothermic Welding of Grooved Rails FE/04/14: A survey of UK tram and light railway systems relating to the wheel-rail interface (Health and Safety Laboratory) RSSB Taking Safe Decisions 2019					
RELATED TRAINING COURSES:				RELATED LEGISLATION:	
Understanding Derailments				Health and Safety at Work Act etc. 1974 The Railways and Other Guided Transport Systems (Safety) Regulations (ROGS) 2006 (as amended) Highways Act 1980	
CHANGE NOTES:					
Date of Issue	Issue No.	Revision No.	Reviewer	Details of Revision	
26/04/2023	01	01	LRSSB	Amendments to text / format	

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Revisions from Previous Issue

Changes to Page 1: removal of the named preparer, reviewer and authorising person and insertion of an explanatory note in relation to the status of this guidance document.

Changes to the Introduction to be consistent with other LRG documentation.

Additional term added to Table A from existing text.

Additional text to Introduction to be consistent with other LRG documents.

Text added / amended to aid clarification where required / appropriate including to 3.5, 3.6, 4.4 and 4.11.

Minor amendments to Appendix 1 and Appendix 2.

Numerous minor presentational, minor factual and typographical changes.

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TERMS AND ABBREVIATIONS

Table A – Terms

Term	Definition
Approved and Competent Person	A person who has been approved by the Light Rail system as sufficiently qualified to undertake certain prescribed safety critical tasks.
Broken Rail	A rail which before removal from a track has either a fracture through the full cross section or a piece broken out of it which renders its unserviceable.
Non-Conformance Report	A report of nonconformity which is the failure to meet one or more of the existing requirements.
Operational Control Centre	The part of the system that authorises and controls the operation of and provision of services on the Light Rail system (also known as route control, network control, system control).

Table B – Abbreviations

Term	Definition
CWR	Continuously Welded Rail
ESR	Emergency Speed Restriction
GCR	Gauge Corner Restoration
HAZ	Heat Affected Zone
Kph	Kilometres per hour
LRSSB	Light Rail Safety and Standards Board
M	Metres
Mm	Millimetres
Mph	Miles per hour
N/A	Not applicable
NDT	Non Destructive Testing
OCC	Operational Control Centre
ORR	Office of Rail and Road
RSSB	Rail Safety and Standards Board
S&C	Switches and Crossings
TPG	Tramway Principles and Guidance
TSR	Temporary Speed Restriction
UK	United Kingdom
UT	Ultrasonic Testing

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1. Introduction

- 1.1. This guidance supports the high level principles set out in LRG 1.0 Tramway Principles and Guidance (TPG) published by the Light Rail Safety and Standards Board (LRSSB).
- 1.2. This document provides high level guidance for the management of rail breaks in embedded or grooved rail for those delegated this responsibility in relation to UK Light Rail systems (tramways) based on 'line-of-sight' operations only. As with all guidance, this document is not prescriptive and is intended to give advice not to set a mandatory industry standard, and it is based upon goal setting principles as good practice.
- 1.3. Much of this guidance is based on the experience and good practice gained from existing UK Light Rail systems and from published documents. It does not prescribe particular arrangements adopted by any existing UK Light Rail system and is intended to give guidance and advice.
- 1.4. This guidance is not intended to be applied retrospectively to existing UK Light Rail systems. However, owners and operators should consider and assess any implementation of this guidance and / or any subsequent revision, to ensure continual improvement in reducing risks, so far as is reasonably practicable.

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2. Scope

- 2.1. The majority of routes of UK Light Rail systems will include sections that run through urban areas using embedded or grooved rail. Of these, it is likely that some will be on existing highways and shared with other road users.
- 2.2. Historic data demonstrates that over time rails have the potential to break due to wear, latent defects, poor maintenance and / or environmental factors etc.
- 2.3. Due to the nature of some rail breaks, it is not always possible to make the required repairs, or to replace rail immediately and therefore, sufficient mitigation measures need to be put in place to protect against further damage (to track and rolling stock) and / or injury to members of the public, passengers, and staff.
- 2.4. Some of the standard Heavy Rail guidance related to “plain line” or “ballasted” rail are not applicable in embedded sections of track.
- 2.5. This guidance outlines a standard method for assessing and safely managing breaks in embedded and grooved rail until such time as the rail can be replaced or repaired. It provides guidance on the minimum actions required to be undertaken to allow a service to resume safely in the intervening period if possible. It includes both immediate actions that would be expected to be taken upon the discovery of a rail break and also secondary actions once the immediate actions have been undertaken.

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3. Immediate Actions

- 3.1. Any incidence of a suspected broken rail must immediately be reported to the Light Rail system's Operational Control Centre (OCC). The location of the break must be clearly recorded using the appropriate recognised organisational method, such as the following (not exclusively):
 - Pole location;
 - Asset number;
 - Chainage;
 - Mileage;
 - Direction of traffic; and
 - Side i.e. cess or six foot.
- 3.2. The details of the reported rail break must then be communicated by the OCC to the organisation's responsible party or parties.
- 3.3. Details of the rail break must be entered on the Light Rail system's Asset Management System and / or incident log.
- 3.4. If the person reporting the break suspects that a section of the rail might be missing or has been dislodged (even if they are uncertain), then services should be suspended immediately until such time that an approved and competent person can fully assess any defect and the risk it poses.
- 3.5. If the person discovering or reporting the rail break is not sufficiently approved and competent to assess any suspected defect, then an approved and competent person within the Light Rail system must be informed immediately. Where possible, the person discovering the rail break should provide photographs or video footage where possible of the defect to the OCC and / or to the approved and competent person.
- 3.6. If the person reporting the defect is a member of public and where it is safe to do so, a member of staff who is sufficiently qualified and deemed competent by the organisation should be assigned to inspect the site and report the situation to the OCC before any vehicles are permitted to traverse the area of the suspected rail break. This could, for example, be the driver of the next vehicle.
- 3.7. Until such time as an approved and competent person can attend and based on the information provided, the OCC may determine that either:
 - Service vehicles must not continue to operate over the reported rail break, or
 - Vehicles can continue to operate over the reported rail break until such time that the approved and competent person is in attendance and has advised on the suitable mitigation measures that should be put in place to enable operations to continue. Such mitigation measures may include raising and instigating an Emergency Speed Restriction (ESR) or stationing a watchman etc.

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- 3.8. Once on site, the approved and competent person should examine the rail break and record all relevant details available at the time, for example, using a form such as the example Broken Rail is Report Form in Appendix 1 of this document.
- 3.9. While attempting to inspect and assess the defect, it must be noted that the return path could be compromised, particularly on end-fed sections of single line. This could result in, for example, an increase in resistivity, arcing or even dangerous touch potential on the rail and vehicle body.
- 3.10. The competent person should attempt to determine the nature and severity of the defect, advise of the immediate actions to be taken and document these actions. These measures must be communicated to the OCC who will inform the relevant parties of the decisions taken.
- 3.11. After assessment where it is considered that the defect is such that vehicles can continue to operate over the reported rail break with suitable mitigation measures in place, these mitigation measures should only be removed after careful consideration where it has been justified, documented and risk assessed by the approved and competent person(s).
- 3.12. In respect to any ESRs, before any changes are made to lift or raise these measures, they should be documented and agreed by the Light Rail system's stated responsible individual(s) as identified by the Duty Holder. In these circumstances, it is recommended that where possible, RSSB's process of "taking safe decisions"¹ or a similar approach be completed, and the documentation produced. In addition, any such defect or break should be risk assessed on a site by site basis, and should be used to provide the following:
- Authorise the lifting or raising of the ESR by the OCC, and
 - Record the decisions made and the subsequent actions to be taken.
- 3.13. If the defect is discovered during non-service hours, the actions in this guidance should still be followed to ensure that any mitigation is in place before the resumption of services.
- 3.14. Appendix 2 of this guidance offers some additional technical information and guidance on the nature of embedded rail breaks and mitigation measures.

¹ <https://www.rssb.co.uk/en/safety-and-health/guidance-and-good-practice/taking-safe-decisions>

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4. Secondary Actions

- 4.1. Once the full assessment has been carried out by the approved and competent person, a Temporary Speed Restriction (TSR) should be carefully considered if appropriate, based on the criteria in Table App 2.1 of Appendix 2. This would be in place until the break has been replaced or repaired. All decisions taken should be fully justified and documented.
- 4.2. At the earliest opportunity, all relevant parties (for example, the Safety Manager, Engineering Manager, and Operations Manager etc.) should meet at the site of the rail break to carry out a risk assessment to identify any further risks, and to determine any additional actions with timescales for completion. This meeting along with any additional risks identified and actions required, and their timescales should be documented, ideally within the organisational Asset Management System where possible. It is recommended that a specific file should be created in each instance, and all associated documentation be stored within this, and updated as required to act as a central repository for ongoing and historic reference.
- 4.3. The investigation of the broken rail will determine if there are any other cracks present that could lead to further breaks or sections of rail becoming detached.
- 4.4. Testing of the rail can be carried out by a number of methods including magnetic particle inspection or dye penetrant inspection. This should be undertaken within 72 hours of discovering the rail break. If it is deemed necessary by the approved and competent person, arrangements can also be made to carry out ultrasonic testing (UT) of the rail whilst in situ. It is important to note that current methods of testing are unlikely to identify issues associated with submerged aspects of the rail such as the web or foot. Details of any Non Destructive Testing (NDT) inspection of the broken rail should be recorded.
- 4.5. Where feasible, it is good practice to send off the defective rail section for further examination by a competent third party organisation to determine the cause of the defect and in doing so, request an accompanying report.
- 4.6. Until the broken rail is replaced or repaired (as the permanent action), a monitoring regime should be put in place. It is suggested that this include a frequent inspection by the approved and competent person or a member of staff who is sufficiently qualified.
- 4.7. The monitoring regime should include measurements to check for displacement of the rail geometry along with photographic evidence. Where possible, traffic crossing over the break should be watched to determine vertical movement. Any decisions taken regarding changes to the monitoring regime should be recorded and fully justified.
- 4.8. It is assumed that each Light Rail system will have its own Non-Conformance Report which should be completed to document the broken rail from when it was reported. This should remain active until the rail has been replaced or repaired, including its installation, and testing under operational conditions.
- 4.9. A plan should be put in place for a full repair or replacement of the broken rail section at the earliest opportunity.

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- 4.10. If installing a new rail section (also known as closure rail), this should ideally be a minimum of 4.5m in length in line with heavy rail standards, which are based on ensuring that the impact forces from the wheel going over one weld and the resultant rail bending forces are reduced by the time they get to the next weld. This is less of an issue for embedded rail. The absolute minimum should be such that one weld's Heat Affected Zone (HAZ) does not coincide with the adjacent HAZ. For safety therefore, the distance between them should be around 1m. However, this distance may need to be greater in order for the weld to be installed.
- 4.11. If the rail break is a short length vertical fracture or it is within a previous weld and its HAZ, an alternative method could be the use of a wide gap groove rail weld as a replacement. This would negate the need for extensive excavations where a closure rail is used.
- 4.12. Details of the replacement or repair should be documented using the Light Rail system's organisational methods and the Non-Conformance Record updated accordingly.

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APPENDIX 1: EXAMPLE OF A BROKEN RAIL REPORT FORM

(Mark as N/A (not applicable) where the criteria are not applicable)

System / Operator:

Location Details

Line / Track Section	Location (Pole / Chainage)	Rail: Cess / 6'	Inbound / Outbound
Street / Segregated / Ballasted	Transition / Slab End	Gradient	Line Speed
Report Source	Inspected By	Date of Discovery	Rail / Air Temperature (°c)

Rail Characteristics

Grooved / Flat Bottom / S&C	Profile	Grade	Manufacturer
Date of manufacture	Date of installation	Weld Type	Gauge Corner Restoration (GCR)
Date of last grinding	Weld stamped	Date last tested (UT)	Rail

Site Conditions / Details

Fastening type		Fastening condition		Radius	
Sleeper type		Sleeper condition		Corrugation	
Pad type		Pad condition		Existing defects	
Fishplate type		Ballast condition		Slab condition	
Drainage		Wet Beds			
Polymer type		Polymer condition			
Comments					

Broken Rail Details (Pre Removal)

Description				
	mm		Yes / No / NA	Vicinity of heat affected area

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Vertical displacement		Direction of Travel		Yes / No	Distance from Weld
Horizontal displacement		Direction of Travel			
Gap between rail ends		Foot corrosion		UT Tested	
Comments					

Actions Required

Temporary Speed Restriction (TSR) required	Authorisation to continue service		Authorised by:
Reduced From mph / kph: To mph / kph:			
TSR signs in place	Yes / No	Date / Time installed	Operations / Drives informed
Reduced From mph / kph: To mph / kph:			
Monitoring regime agreed & implemented Yes / No	Frequency of inspection	Inspection method (visual / measured)	Traffic notice updated

Broken Rail Details (Post Removal)

Please supply as much information as possible in relation to the break and environment conditions along with photographic evidence and drawing where applicable.

Evidence of foot corrosion	Missing / Defective support	Multiple breaks

Attach Images

Details updated and input digitally	Date Inputted	Inputted by
Submitted to UKTram / LRSSB	Date submitted	Submitted by

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Broken Rail Removal

Date of New Rail installed	Length of rail installed	Installed by
Welds Inspected / Stamped	Work approved by	Broken Rail recovered

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APPENDIX 2: TECHNICAL GUIDANCE

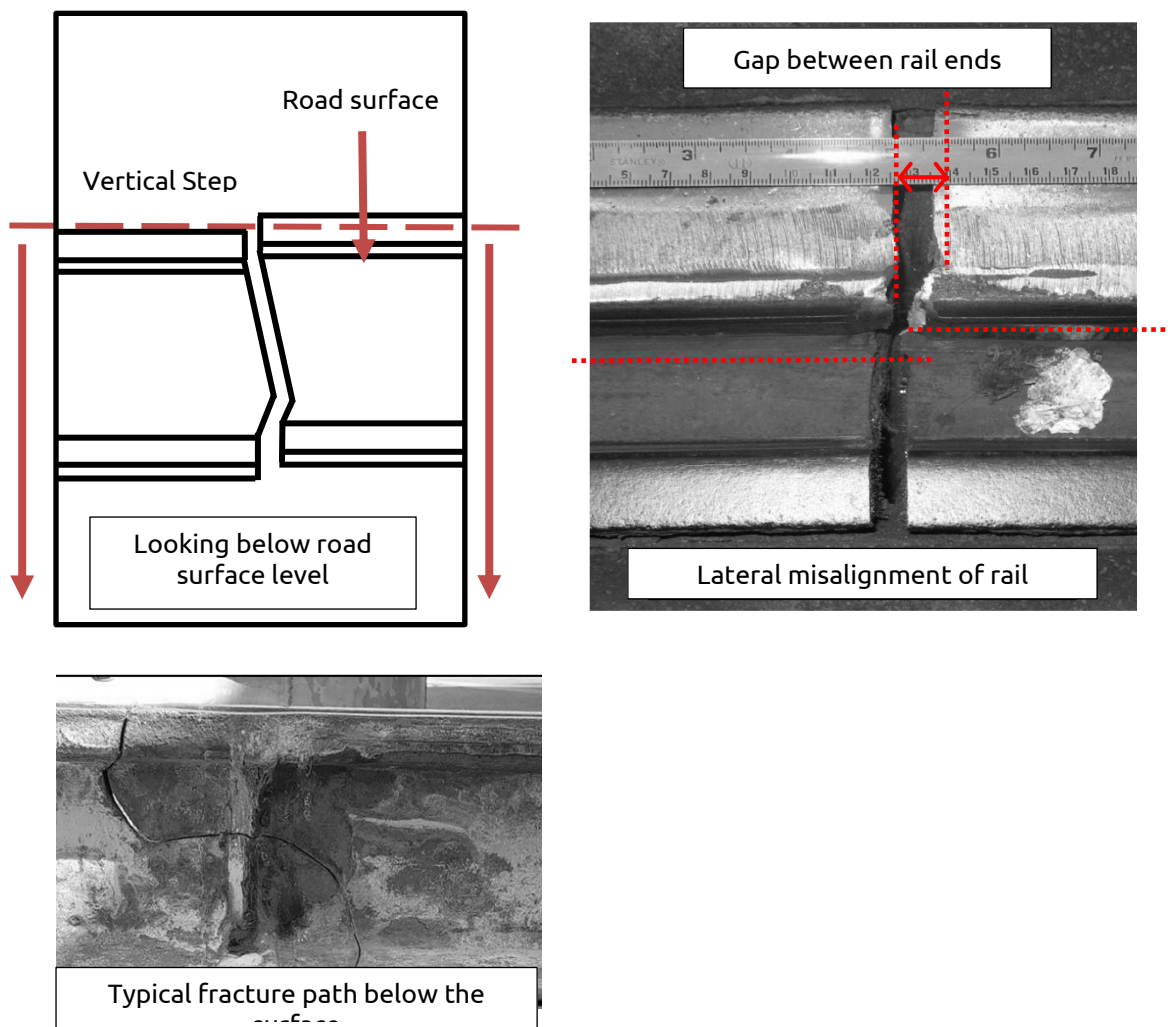
- 1) The following provides technical guidance and information on breakages to embedded rail, including additional mitigating measures that could be undertaken on the discovery of a broken rail.

Broken Rail / Polymer

Rail

- 2) A grooved rail embedded in polymer could be completely broken through from top to bottom either vertically or inclined as shown in Figure App 2.1 below.

Figure App 2.1 Complete Rail Break



- 3) The assessment of the broken rail should include the condition of the supporting polymer, the gap between rail ends (measured at the head), vertical step, and lateral and misalignment of the gauge corner.
- 4) As it is likely that the rail will void under load, any measurements undertaken should be carried out when it is static, and any changes recorded. As the rail in these locations are

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likely to be shared with other road users, all site safety precautions such as signage and site protection (in line with NRSWA²) must be in place prior to any inspections taking place.

- 5) Table App 2.1 below provides a reference guide based on rail break characteristics and can be used to determine the actions to be taken based on the combination of the notes provided below the table. However, each Light Rail system should determine what is an appropriate set of actions in each instance, and to review and determine on a case by case basis.

Table App 2.1: Rail Break Conditions and Actions

Condition	Gap Between Rail Ends	< 0.5m from Joint or Another Defect	≥ 0.5m to < 2m from Joint or Defect	< 2m from Weld	≥ 2m from Weld, Joint or Defect
Good Polymer and Lateral Misalignment ≤ 5mm	≤ 25mm	<u>10 mph / 16kph</u> Note 1	<u>Line Speed</u> Note 2	<u>Line Speed</u> Note 3	<u>Line Speed</u> Note 3
	> 25mm and ≤ 50mm	Stop Traffic	<u>5 mph / 8kph</u> Note 2	<u>10 mph / 16kph</u> Note 2	<u>10 mph / 16kph</u> Note 2
	> 50mm	Stop Traffic	Stop Traffic	Stop Traffic	Stop Traffic
Poor Polymer and Lateral Misalignment ≤ 5mm	≤ 25mm	Stop Traffic	<u>5 mph / 8kph</u> Notes 1 + B	<u>10 mph / 16kph</u> Notes 1 + B	<u>10 mph / 16kph</u> Notes 1 + B
	> 25mm and ≤ 50mm	Stop Traffic	Stop Traffic	<u>5 mph / 8kph</u> Notes 1 + B	<u>5 mph / 8kph</u> Notes 1 + B
	> 50mm	Stop Traffic	Stop Traffic	Stop Traffic	Stop Traffic
Lateral Misalignment > 5mm (Note A)	All	Stop Traffic	Stop Traffic	Stop Traffic	Stop Traffic

Notes

1. *Inspection to be carried out daily*
2. *Inspection to be carried out every 2 days*
3. *Inspection to be carried out weekly*
- A. Alignment can be improved by grinding for a short distance to remove any sharp steps. The track can then be reopened to Light Rail and motor vehicle traffic at 5mph / 8kph. Supporting polymer needs improvement (in terms of reinstating the polymer or additionally supporting the rail) within 72 hours.
- B. Supporting polymer needs improvement (in terms of reinstating the polymer or additionally supporting the rail) within 72 hours.

² NRSWA - New Roads and Street Works Act 1991: <https://www.legislation.gov.uk/ukpga/1991/22/contents>

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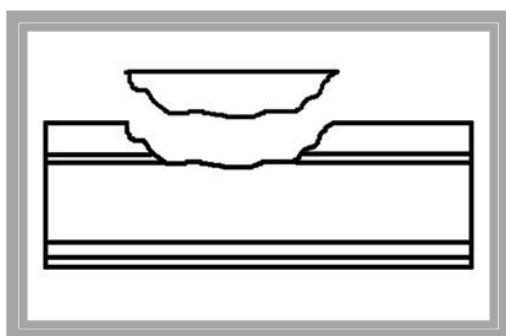
Polymer

- 6) In some cases, the polymer may be the issue instead of / as well as the rail itself. Poor polymer criteria can include any of the following (not exclusively):
- Detachment of polymer from rail or concrete;
 - Missing polymer;
 - Significant movement of the rail when vehicles pass over; and / or
 - Evidence of pumping of water or mud around the polymer and rail end.
- 7) Actions to be carried out include the removal of the existing material and pouring of new polymer or supporting material. Additional support can be provided by fishplates being affixed to the web of the rail by welding or by shims prior to the new polymer being poured. However, this will depend on the construction of the track.
- 8) Where the polymer is poor and there is significant movement of the rail as vehicles pass over it, then the support of the rail needs to be improved. Once the support of the rail has been improved, the speed limit and inspection regime can be reviewed based on the criteria in Table App 2.1 above.

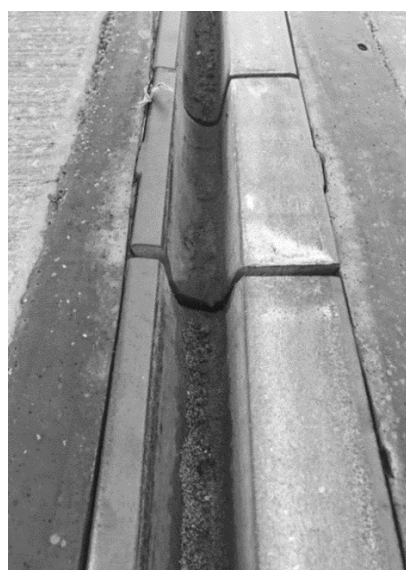
Part of Rail Broken Away

- 9) This is where any part of the rail is broken away presenting a gap to the running of the wheel including at a rail joint, as illustrated below in Figure App 2.2. A double fracture path can result in a section of the head dislodging.

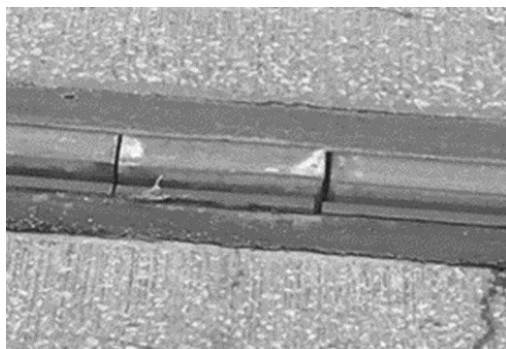
Figure App 2.2: Partial Rail Break



Section
of rail
head
...



Double fracture path



Double fracture path

- 10) The occurrence of part of a rail breaking away is less common than a single break, but

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poses a far greater risk. In extreme cases, the broken section of the head of the rail can completely dislodge from its surroundings resulting in a high risk of the potential of a vehicle derailling.

- 11) Table App 2.2 below sets out the speed restrictions to be imposed and any other action to be taken in the event of part of the rail being broken away. As with previous recommendations, each Light Rail system should determine what is an appropriate set of actions in each instance, to review and determine on a case by case basis.

Table App 2.2: Speed Restrictions and Other Actions

Condition	Length of Head Broken Away	< 0.5m from Joint, Weld or Another Defect	≥ 0.5 from Weld, Joint or Defect
Good Polymer and Lateral Misalignment ≤ 5mm	≤ 25mm	<u>5mph / 8kph</u> Note 1	<u>Line Speed</u> Note 2
	> 25mm and ≤ 50mm	<u>5mph / 8kph</u> Note 1	<u>10mph / 16kph</u> Note 1
	> 50mm	Stop Traffic	Stop Traffic
Poor Polymer and Lateral Misalignment ≤ 5mm	≤ 25mm	<u>5mph / 8kph</u> Notes 1 + B	<u>5mph / 8kph</u> Notes 1 + B
	> 25mm and ≤ 50mm	Stop Traffic Note B	Stop Traffic Note B
	> 50mm	Stop Traffic	Stop Traffic
Lateral Misalignment > 5mm (Note A)	All	Stop Traffic	Stop Traffic

Notes

1. *Inspection to be carried out twice per week*
2. *Inspection to be carried out weekly*
- A. Alignment can be improved by grinding for a short distance to remove any sharp steps. The track can then be reopened to traffic at 5mph / 8kph. Support needs improvement within 72 hours.
- B. Support needs improvement within 72 hours.