International Experience of Cyclist/Tram Integration (TO29)

Report: Co-existence of Cyclists and Trams

Date: Jan 2012
Client: National Transport Authority (NTA)
Document Ref: NTA-TO29-JEA-000001
Jacobs Engineering U.K. Limited

This document has been prepared by a division, subsidiary or affiliate of Jacobs Engineering U.K. Limited (“Jacobs”) in its professional capacity as consultants in accordance with the terms and conditions of Jacobs’ contract with the commissioning party (the “Client”). Regard should be had to those terms and conditions when considering and/or placing any reliance on this document. No part of this document may be copied or reproduced by any means without prior written permission from Jacobs. If you have received this document in error, please destroy all copies in your possession or control and notify Jacobs.

Any advice, opinions, or recommendations within this document (a) should be read and relied upon only in the context of the document as a whole; (b) do not, in any way, purport to include any manner of legal advice or opinion; (c) are based upon the information made available to Jacobs at the date of this document and on current UK standards, codes, technology and construction practices as at the date of this document. It should be noted and it is expressly stated that no independent verification of any of the documents or information supplied to Jacobs has been made. No liability is accepted by Jacobs for any use of this document, other than for the purposes for which it was originally prepared and provided. Following final delivery of this document to the Client, Jacobs will have no further obligations or duty to advise the Client on any matters, including development affecting the information or advice provided in this document.

This document has been prepared for the exclusive use of the Client and unless otherwise agreed in writing by Jacobs, no other party may use, make use of or rely on the contents of this document. Should the Client wish to release this document to a third party, Jacobs may, at its discretion, agree to such release provided that (a) Jacobs’ written agreement is obtained prior to such release; and (b) by release of the document to the third party, that third party does not acquire any rights, contractual or otherwise, whatsoever against Jacobs and Jacobs, accordingly, assume no duties, liabilities or obligations to that third party; and (c) Jacobs accepts no responsibility for any loss or damage incurred by the Client or for any conflict of Jacobs’ interests arising out of the Client’s release of this document to the third party.
Table of Figures

1. Typical Embedded Rail Design
2. Typical Grooved Rail
3. Typical Embedded Rail in Dublin
4. Wheel in Rail Groove
5. Annual number of fatalities in all crashes in the Netherlands (SWOV)
6. Centre Platform in Berlin
7. Cross Section of VeloStrail Construction [vignole rail]
8. a,b,c,d, VeloStrail Construction [vignole rail]
9. Naas Road Track Slab
10. a,b Phoenix Rail Filler
11. a,b Phoenix Safety profile for Grooved Rail
1 Introduction

1.1 Client Requirements

1.1.1 Description of Task as Received from the Client

Concerns have been raised in relation to the co-existence of cyclists and trams in the same corridor and, in particular, the risk for cyclists of accidents / incidents involving bicycle wheels getting caught in tram tracks.

An information note is requested on international experience on the co-existence of cyclists and trams, addressing such items as:

1. What is the general practice in other cities in terms of allowing or facilitating cyclists in tramline corridors – some actual international references would be useful;
2. Are there any available statistics on accident frequency involving cyclists in cities which allow co-existence between these two modes?
3. Where there is co-existence, are there any special arrangements put in place generally to prevent cycle wheels entering tram tracks?
4. Is there any research readily available on tram/cyclist interaction?
5. Are there general principles that should be adopted in facilitating such interaction?
6. It is understood that inserts may be available for use in tram tracks which would prevent cycle wheels being caught but that there are possibly issues of effectiveness and durability associated with such inserts. Can some details in relation to this measure be assembled – what is the system; is it expensive; is it effective; is it durable; where is it in active use?

1.2 Purpose

The purpose of this report is to examine the various international solutions regarding the co-existence of cyclists and trams in the same corridor.

1.3 Scope

In order to address the clients’ questions this document will concentrate on 3 key areas:

- The general practice in other cities in terms of allowing or facilitating cyclists in tramline corridors,
- Providing available statistics on accident frequency involving cyclists in cities which allow co-existence between these two modes
- Where there is co-existence, indicating the special arrangements put in place to prevent cycle wheels entering tram tracks and any general principles that should be adopted in facilitating such interaction.

1.4 Study Methodology

The report is a high level discussion document which has been compiled using personal experience in the UK, Ireland and Germany as well as research of Dutch and USA systems. Information reported in the press or published by the respective transport agency has been referenced where available.
1.5 References

[1] SWOV Fact sheet Bicycle facilities on road segments and intersections of distributor roads, SWOV Institute for Road Safety, Leidschendam, Netherlands, October 2004


[6] Sign up for the bike: Design manual for a cycle-friendly infrastructure, Published by C.R.O.W 1993 ; the successor of this publication is the ‘Design manual for bicycle traffic’ CROW-record 25 2007

[7] Road Safety Audit Road Safety inspection Was ist das?, Das österreichische Verkehrsjournal Feb 2010

[8] Report of the Director, Net to the GNLRT Advisory Committee 10th June 2008
2 The Challenge

The challenge, which the travelling public presents to today’s transport designers and city planners, is to find solutions that allow as many modes of transport as possible to coexist in the smallest possible physical footprint on the public realm. It is this competition for the right to use or continue to use highly desirable pre-existing corridors - in particular with the increased need for higher density transport modes - which leads to solutions which may be realistic given the boundary conditions but are perhaps sub-optimal when compared to what is achievable in a green field site.

2.1 Wheel – Road –Rail Interface

The current embedded rail design in Dublin is similar to that shown in Fig 1 where the material and finish of the cover may vary depending on the needs of the specific location e.g. bitumen, printed concrete etc. It is worth noting a few key design parameters and hazards:

- **Steel has a low coefficient of friction when compared to the carriageway surface and hence is slippery in particular when wet.**

- **The rail groove is an essential part of the steering system of the light rail vehicle and has the function of maintaining the wheels in their correct position. A number of grooved rails exist with differing groove width depending on the tram wheel profile and the alignment requirements.**

- **Due to construction tolerances and the need to provide a minimum wear lifetime the rail is usually installed slightly proud of the carriageway surface.**

- **The horizontal rail spacing is approximately the same as the wheel base of many motor cars which results in the need to separate these modes of transport so that the car driver does not drive on / brake on the rails.**
Some bicycle wheels, in particular the narrow racing bike wheel, will fit within the rail groove and can become stuck.

2.2 Highway Spacing

Due to the lack of available space in many inner city areas worldwide, significant separation of the various transport modes is often difficult to achieve as the typical multimodal road layouts include for the provision of:

- Designated car parking bays
- Cycleway
- Tram Stop (sometimes using a bulb-out { extension of the tramstop into the highway})
- Bus stop
- Left / Right turn only lanes
- Traffic calming measures etc
3 Accidents and Accident Statistics

In most countries the occasionally severe accidents involving falls due to the cyclist becoming stuck in the rail groove are reported by the press. The accident registers of most countries (if they exist) do not specifically codify this type of accident and it must be assumed that any such accidents are contained within the higher level national statistics. It is generally accepted that accidents involving getting stuck in the rail groove or slipping on the rails (a related problem due to loss of friction) are under reported.

3.1 Austria

The Austrian Police (LPK-Niederoesterreich) reported on its website an accident in Baden on 16th May 2011 in which a 16 year old cyclist fell and had to be hospitalised after her front wheel was caught in a rail groove.

3.2 The Netherlands

The Dutch Council for Transport Safety in its report “Security risks in the Dutch City Tram” [ref: [3]] presented accident statistics for accidents involving cyclists. This data however was not broken down such that accidents involving the rail groove specifically could be identified. One of the reports recommendations was to conduct a “thorough analysis of a selected and limited number of accidents that have known benefits, marking problems of city trams in city. This study is primarily from a traffic engineering perspective and provides recommendations in the area of infrastructural facilities”. It also highlighted the absence of a central accident register that was accessible to all stakeholders.

The Dutch Institute for Road Safety Research (SWOV) reports [ref: [2]] that the number of casualties among users of public transport (bus, tram/light rail, metro and train) is limited with an annual average during the past ten years (2000 - 2009) of 1 fatality and 19 serious road injuries. The hazards of public transport vehicles are much bigger for other road users with an annual average of 41 fatalities and 138 serious road injuries during the same period. Among them, 116 are casualties (16 of them fatalities) of crashes with buses and 63 (25 of them fatalities) of crashes with a tram or train. Additionally it reported that the trend for fatalities, as a consequence of tram collision seems more erratic because of the low statistics (an annual average of seven fatalities) while the number of serious road injuries caused by tram collision alone was not shown, because this data is not reliable in the current crash registration.
Again it was not possible to identify rail groove accidents from the data presented by SWOV.

3.3 Germany

3.3.1 Dasselstraße Tram Stop

The German Cycle Club (ADFC Köln) in its publication Fahrad! reported on an accident in which a cyclist fell from her bike and was injured when the front wheel stuck in the rail groove at the approach to the Dasselstraße tram stop. To facilitate the building of a mobility access ramp at the tram stop, a section of the cycle lane was used, reducing its width considerably. Underreporting of accidents is mentioned and a request to the public to report similar accidents.

3.3.2 Höninger Weg

WDR Cologne (TV Station) reported on the 8th June 2011 that a cyclist (50) was killed in an accident in the Köln-Zollstock area. He was travelling towards the city centre on the Höninger Weg and in the vicinity of the Gottesweg tram stop fell against the last car of the Line 12 Kölner Verkehrsbetriebe (KVB) tram that was travelling in the opposite direction. According to the Police his front wheel got stuck in the rail groove and he lost his balance falling against the tram.

In the same report the German Cycle Club (ADFC) Cologne explained that in Germany all cyclists are required to cycle at least 1m from parked cars, while cars overtaking cyclists are required to be at least 1.5m from the cyclist and therefore, in this location, would be driving against oncoming traffic. Cars are therefore unable to overtake legally but continue to do so.

The Kölner Verkehrsbetriebe (KVB – Cologne Tramway Operator) has stated that only a small number of accidents happen and principally to cyclists with narrow racing bike tyres which get stuck in the groove when they cross at a very narrow angle to the rail.

This report contains some footage showing the cause of some “predictable” accidents cars exiting or stopping to enter parking bays, car doors opening suddenly, pedestrians jaywalking - which can take the cyclist by surprise forcing
them to react quickly to avoid a collision. The presence of a rail groove complicates these situations.

3.4 UK

Most UK systems have had isolated reports of slipping on the rail and falls due to the cyclists’ wheel getting caught in the rail groove.

3.4.1 Nottingham

Since the tram tracks were first installed in 2002 there have been a total of 22 cycle accidents, along the extent of the on-street tramway reported to the police. The tram tracks were considered to be a possible contributory factor in only seven of these accidents, two of which involved a serious injury. In comparison, in the six years prior to 2002 there were 30 reported accidents involving cyclists along these roads. It is acknowledged that, due to many cycle accidents not being reported, there will be an element of under-reporting in these figures [ref: [8]].

The length of road that includes Fletcher Gate and Middle Hill is perceived to present particular difficulties to cyclists and in response to the recent accidents, the City Council’s Road Safety Team has undertaken a further review of this location. They have concluded that, whilst the tram tracks provided a possible contributory factor to the accidents, this was no worse than factors caused by other traffic, street furniture (e.g. service covers) or road defects and that compared to other roads, the presence of the tram means there are fewer road defects, less street furniture and the tram may have contributed to a reduction in traffic levels [ref: [8]].

It is a requirement at tramstops that the tram doors must be as close as possible to the platform edge to ensure safe access and egress from the vehicle. It is therefore not possible to allow space between the inside rail and the platform for cyclists to use. Also in situations where the total street width does not allow for a cycle lane to be located behind a platform (as is commonly the case in the urban environment) it is necessary for cyclists to cross the inside rail and to ride in the section of carriageway between the rails in order to pass through the stop. This is the case at Lace Market and in such situations cyclists are encouraged to cross the rail at as steep an angle as possible, on the approach to the tramstop, in order to reduce the likelihood of either slipping on the rails or getting their wheels trapped in the groove [ref: [8]].

3.5 USA

3.5.1 Portland

The Lloyd District Transportation Management Association (LDTMA) commissioned a report [ref: [5]] on the interaction between bicycles and streetcars (trams) which included a web survey that had 1520 respondents.

- Over 67% of respondents reported that they have experienced a bike crash on tracks, demonstrating that bike-track crashes are a major and underreported problem for Portland-area bicyclists. Most crashes do not result in life-threatening or permanently disabling injuries.
4 Techniques to avoid the issue and their shortfalls

It should be noted from the outset that there are often completely different operating modes or traffic management design solutions in other countries and that any individual solution must be considered in the context of that countries approach to road transport. In the Netherlands, Poland and Australia amongst others the tram is centre running in a segregated central median or in the centre of the road alignment and passengers cross the road to board the vehicle. In the USA, UK, Germany and Ireland the tram stops at the street kerb. While there are many commonalities between all tram systems, this difference (amongst others) must be appreciated prior to reviewing local solutions.

4.1 Australia

4.1.1 Melbourne

Cyclists allowed and facilitated in tramline corridors:

Bicycle Victoria has produced an in-depth guide on how to cross tram tracks (including shifting your weight) and recommends using an angle greater than 45°. The Melbourne right turn solves the issue of blocking traffic at intersections by requiring the commuter to wait on the left side of the road until the traffic lights change and then executing the 90° turn. The advantage when compared to a traditional right turn is that the need to cross tram tracks on the approach to the intersection at a narrow angle is eliminated. The disadvantage is the space requirement. Sufficient space must be available in the carriageways for which this turn is to be used. In some Melbourne locations, due to centre running and where street widths allow it, a segregated cycle lane is provided between the footpath and the allocated car parking spaces.

4.2 Austria

Recommendations for cycle friendly design use a mixture of cycle lanes and routing to 90° turns [ref: [7]].

4.2.1 Baden

Cyclists allowed in tramline corridors:

4.3 Germany

4.3.1 Cologne

Cyclists allowed and facilitated in tramline corridors:

In Issue 2 page 8 of FahrRad! [ref: [4]], the Cologne Tramway Operator (KVB) is reported as having written that they have tried rubber inserts in the rail groove but found that they did not adhere well and required significant maintenance as the tram wheel wore down / ripped the material.

The KVB further indicated in a recent interview (Appendix 1.1, section 3.3.2 above) that the KVB does not recommend crossing the tram track at a narrow angle and reconfirmed that the KVB does not think that a rubber insert in the rail groove is a feasible solution. The insert is constantly damaged by the tram wheel, compressed
over time and often gets stones or other materials stuck in it which is a danger to all road users.

4.3.2 Berlin

Cyclists allowed and facilitated in tramline corridors:

In some areas centre platforms are used and in those areas the risk for cyclists becoming caught in the rail groove is somewhat reduced.

Figure 6 Centre Platform

The German Cycle Club (ADFC Dresden) illustrated the solution used in Berlins Kastanienallee to inform all road users where cyclists are obliged to travel. Pictograms have been printed every 20m on the road between the tram tracks (see Appendix B1.2).

4.4 Netherlands

Separated cycle tracks (or, less frequently, bike lanes) are provided for cyclists to use the right of the right-hand vehicle lane. Turns are controlled by bicycle turn signals or occasionally the Melbourne right turn [ref: [1]]. The Dutch design manual Sign up for the Bike states that “Tram rails considerably aggravate the action of riding a bicycle. Cyclists must avoid crossing the rails at an acute angle especially in wet weather.” [ref: [6]]. The Dutch Design Manual for Bicycle Traffic states that cyclists should be able to cross the rails at an angle of at least 45º, but preferably more than 60º [ref: [6]].

There are 16 million cyclists in the Netherlands and the children there are educated from an early age as to the correct way to cross tram tracks.

4.4.1 Amsterdam

Cyclists allowed and facilitated in tramline corridors

4.5 United Kingdom

4.5.1 Nottingham Express Transit (NET)

Cyclists allowed and facilitated in tramline corridors

The design development stage for NET was concurrent with the legal proceedings of the Roe case. As the outcome from that case was emerging it was decided to undertake an internal review and risk assessment of the possible implications for Nottingham (this review primarily concerned motor vehicles but some aspects are applicable to cyclists).
The design philosophy that arose from this assessment was:

- Avoid concurrent running, OR
- Provide measures to discourage drivers from driving on the rails.

The typical measures developed and used in Nottingham to avoid the coincidence of the rails and rubber tyres are:

- The centreline of the lane for vehicles was offset by 500mm from the centreline of the rails.
- Control of the rail level alongside the road surface.
- All materials in the carriageway, excluding the actual tram rails were designed with similar skid resistance properties.
- Traffic signs and road markings.

(a) Control of Rail Level

Control of the rail level is important for cyclists and car drivers as the higher the rail protrudes above the carriageway the more likely that the cycle wheel will completely lose contact with the road surface, while it is on the rail, leading to the possibility of skidding or slipping and the cyclist losing their balance.

The difference in levels between the top of the rail and adjacent road surface was subject to much debate in the Roe trial (see Appendix A4.5). Whilst appearing to accept that to achieve ‘zero’ tolerance along the whole network was not practical nor perhaps the intention of the drafters of the 1870 Tram Act (which formed part of the Sheffield Act), the judge was unable to determine what the tolerances should be. However, it was concluded that the differences in level in Sheffield were not acceptable.

The NET designers sought guidance from HMRI, the highway authority, etc but were unable to obtain a definitive answer. The only source of guidance obtained was the New Roads and Street Works Act (NRSW Act) which defines for the reinstatement of trenches - a tolerance of ± 3mm.

Although, NET aimed to achieve a tolerance of ± 2mm, inspections revealed that the tolerance generally achieved was ± 3mm. Those areas where the difference in level exceeded 3mm were individually inspected and a risk assessment undertaken before these sections were adopted.

There are four elements which form the road surface; the tram rail, the polymer surrounding the rail, the concrete surround to the rail (approximately 300mm wide) and the flexible pavement. It was decided that the method of construction should be such as to ensure a constant plane across all four materials.

The methods of construction adapted in Sheffield and Croydon involved installing rails into preformed carriageways. The NET designers decided that to ensure control of levels, it would be better to install the rail before the road pavement.

(b) Skid Resistance

Control of the skid resistance is important for cyclists and car drivers. The presence of a slippery rail is compensated by increasing friction in the immediate vicinity of the rail, reducing the possibility of skidding or slipping and the cyclist losing their balance.
NET considered that it was essential to obtain consistent characteristics for skid resistance in the polymer, concrete and flexible materials in order to limit the scope for skidding to the rails only.

The same aggregates were used in the concrete and installed in the polymer. An exposed aggregate finish for all concrete surfaces was adopted in preference to imprinted concrete, as it provided a greater assurance of achieving and maintaining the required skid resistance.

Three types of flexible materials were used - Stone Mastic Asphalt primarily, but also Hot Rolled Asphalt and Slag Asphalt.

(c) Traffic Signs and Road markings

In Sheffield, many measures were retrofitted which assisted motorists and cyclists. These included:

- Hatched road markings and relocated lane markings to help delineate lanes for traffic away from the tram rails.
- Coloured surfacing to reinforce the use of hatched markings.
- “Tram ahead” standard signs.
- “Slippery when wet” traffic signs.
- Introducing lower speeds on some routes.

Cycle lanes have been provided along some of the alignment however the main strategy has been to provide and encourage cyclists to use alternative low traffic parallel routes. Cyclists are also encouraged to cross the track at right angles. In complying with Railway Safety Publications 2 (RSP2), friction loss in the vicinity of the rail head is combated by the use of exposed aggregate concrete surfacing or similar.

4.6 Switzerland

4.6.1 Geneva - VeloSTRAIL Application

VeloSTRAIL is a panel system that eliminates the flange grooves by using an easily replaceable flangeway element to close the flange groove. Any rolling stock, will easily compress the replaceable flangeway element but it accommodates enough resistance to provide a flat surface for pedestrians, cyclists, wheelchair users, baby carriages and inline skaters. As an added benefit ice formation in the flange groove is no longer possible.

Smooth transition from one product to another together with an integrated locking and a bolting under the rail head makes driving over the crossing very comfortable. Compact panel units allow simple and cost-effective track maintenance due to short installation and removal. Replacement of the replaceable flangeway element is without removal of the inner panel and requires no machinery and only minimal labour during very short, partial closing periods.

It is not based on the typical grooved rail construction but rather the use of standard vignole rail (T - Rail) and filling the gap between the rails by the use of rubber panels as illustrated in Figure 7 to Figure 8d below.
For a city centre tramway application, the standard rail can be fixed to sleepers which are then embedded into the 1\textsuperscript{st} pour of the reinforced concrete slab or clipping to base plates which are again fixed to the reinforced concrete slab.

An example of this slab track construction (vignole rail clipped to a track sleeper embedded in a concrete trackslab) can be viewed on the segregated section of the Naas Road. Once the concrete has cured then the panels can be inserted and the road and paths brought to final levels.

This construction has a number of key differences to the current Dublin embedded track using grooved rail (see Figure 1), the most obvious being that the highway between the rails is now principally constructed from hard wearing rubber panels.
Some issues that need to be considered are:

(a) **Water Ingress**

Any water that penetrates under the rubber panels and remains (ponding) may make the escape of stray current a little easier leading to a higher corrosion rate in that location. The final design therefore should pay particular attention to highway drainage requirements and in particular to draining beneath the panels. One advantage is that the panels are removable allowing the possibility to check for water ingress and the unblocking of drains.

(b) **Cost**

The cost of the product is significant at a min. €800k / kilometer and there is an ongoing maintenance requirement e.g. replacement of rubber strips due to wear caused by the wheel flange at approx. €50 / 600mm strip. There would however be a small saving due to the need for less concrete in this solution when compared to the “classic” fully embedded solution.

(c) **Longevity**

The guaranteed lifetime of veloSTRAIL (especially the replaceable rubber parts) is 1 million (one million) axles or 2 years although the average lifetime can range from 2 to 5 years, depending on how many train axles pass through the rubber parts.

The inner panels have an average lifetime of 15 to 25 years or longer, depending on the traffic load.

(d) **Compatibility with Luas**

The T rail selected could be the S49 standard rail profile used currently on Luas (eliminating a compatibility and spares issue).

(e) **Suitability for the Luas System**

This solution would require extensive demolition and rebuild if it were to be retrofitted to existing embedded sections of the Luas system but could be considered for high risk areas in an extension to the Luas network.

### 4.7 USA

#### 4.7.1 Portland

Cyclists allowed and facilitated in tramline corridors

The Lloyd District Transportation Management Association commissioned a report [ref: [5]] on the interaction between bicycles and streetcars (trams) which included site visits to Copenhagen, Amsterdam, Stockholm, Malmö, and Helsinki.

This report discusses a series of common issues that have been encountered when designing co-existing cycle and tramways.
4.8 Dätwyler Sealing Technologies Deutschland GmbH

4.8.1 Phoenix Rail Filler

Dätwyler Sealing Technologies Deutschland GmbH produces under its Phoenix Profile range a rubber insert that can fill a gap between a T-Rail and the walls of a concrete trough in which it is fixed. This design solution offers the possibility to obtain the same surface finishes as are currently in Dublin without however the presence of a large rail groove.

In essence this product allows the operator to adjust the width of the groove, reducing it to the minimum necessary for the vehicle.

This is an important operational factor and for an 80mm residual groove it limits the light rail vehicle speed passing over it to 20 km/h. A bespoke residual groove width can be ordered.

There are a number of construction options in terms of fixing the rail to sleepers which are then embedded into the 1st pour of the reinforced concrete slab or clipping to base plates which are again fixed to the reinforced concrete slab (see fig 9). The trough around the rail can then be formed by shuttering prior to the 2nd pour which would be to final levels. The Rubber profiles are then wedged into their final positions around the rail.

It should be noted that VeloStrail and Phoenix Rail Filler are but 2 examples of compressible elements and there are other suppliers offering similar products and significant research would be required to determine the optimum solution in terms of operational performance and total lifecycle cost.

(a) Water Ingress

Any water that penetrates under the rubber inserts and remains (ponding) may make the escape of stray current a little easier leading to a higher corrosion rate in that location. This solution is compatible with the Phoenix Rail Boot stray current protection system but the final design should pay particular attention to drainage requirements in the trough beneath the inserts. One advantage is that the inserts are removable allowing the possibility to check for water ingress and the unblocking of drains.
(b) Cost

The product is available in 3 types of raw material and the lifecycle cost varies depending on the quality of raw material selected. See Appendix B 4.8

(c) Longevity

The product is available in 3 types of raw material and the longevity for a fixed quantity of traffic passing over it varies depending on the quality of raw material selected. See Appendix B 4.8

(d) Compatibility with Luas

The T rail selected could be the S49 standard rail profile used currently on Luas (eliminating a compatibility and spares issue).

(e) Suitability for the Luas System

This solution would require extensive demolition and rebuild if it were to be retrofitted to existing embedded sections of the Luas system but could be considered for high risk areas in an extension to the Luas network.

4.8.2 Safety Profiles for Grooved Rails

Dätwyler Sealing Technologies Deutschland GmbH produces under its Safety Profile for Grooved Rails range a rubber insert that can fill a gap of a grooved rail. This product however is recommended only for rarely frequented or "dead" tracks in industrial areas. In highly frequented areas with for example Ri 60 profile the company is trying to develop a new solution. No guarantee is given by the manufacturer on the longevity of the product given the large number of factors that may influence its suitability.

Figure 11a Phoenix Safety Profile

This type of product (also offered by other manufacturers) is not suitable in its present form for use in heavily trafficked areas until the longevity issue is solved. It has been included in this document to provide a more complete overview of the current market and the difficulties faced by manufacturers to find a cost effective solution to eliminate the rail groove.

Figure 11b Phoenix Safety Profile
4.9 Recommendations

- Separated routes are universally preferred, usually in the form of a grade-separated cycle way, but sometimes in the form of a parallel low-traffic bicycle route.
- Bicycles must be integrated into tramway planning processes from the earliest stages.
- Facilities should where possible facilitate right-angle turns by cyclists.
- Additional cyclists and motorist education (in terms of safety warning and alternative routes).
- Leave sufficient space between tram track and platform curb such that bicycles can proceed safely or provide sufficient advanced warning and opportunity for the cyclist to cross the rail.
- Cycle lane detours behind the tram stop are not generally a preferred facility type, but if they are used care must be taken on downhill alignments to keep bicycle speeds low and avoid conflicts with pedestrians.
- Lowering vehicle volumes and speeds on tram routes can create safer conditions for cyclists when crossing the rail as they have more time and feel less threatened by the traffic flow.
5 Standards

5.1 United Kingdom

Railway Safety Publications 2 (RSP2) Guidance on Tramways contains the following clauses concerning the crossing of the rail by cyclists:

Clause 79

Where it is necessary for cycle lanes to cross tram tracks, these intersections should be, as far as possible, at right angles to the tracks. Where the achieved crossing angle is less than 60º, consideration should be given to alternative crossing layouts and other measures that mitigate the risks faced by cyclists. Consideration should be given to measures that raise awareness of the presence of rails in the carriageway such as signage or use of texture.

Clause 120

Where rails are laid in a carriageway that is used by rubber-tyred vehicles travelling in the same general direction as the rails, the effect that the steel rail and any flexible filling will have upon the skid resistance of the carriageway surface should be considered, particularly when vehicles move across the carriageway and their tyres cross over the rails at shallow angles. The track should be located within the carriageway so that, as far as is reasonably practicable, it does not coincide with the path normally taken by the wheels of rubber-tyred vehicles.

Note: Additional warnings of the risk of skidding may need to be given to motorists. Rubber-tyred vehicles may skid when accelerating, as well as when braking or cornering.

Clause 122

Where flexible filling material is used, that material should, so far as reasonably practicable, have a skid resistance comparable with normal road surface material.

5.2 Germany

The Verordnung über den Bau und Betrieb der Straßenbahnen (Straßenbahn-Bau- und Betriebsordnung - BOStrab) does not contain specific recommendations to prevent bike wheels entering tram tracks.

5.3 Netherlands

The Dutch Design Manual for Bicycle Traffic states that cyclists should be able to cross the rails at an angle of at least 45º, but preferably more than 60º [ref:[6]].
A 4.3  Germany

Television Report “Gefährliche Schienen” - MEDIATHEK - WDR.de

“Radfahrer haben es in Köln nicht leicht. Sie müssen sich an vielen Stellen die Straße mit Autos und der Straßenbahn teilen. Besonders tückisch für Zweiradfahrer können die Schienen der Straßenbahn werden. Wer hier hineingerät, kann schwer stürzen”.

A 4.5  The Roe Case (United Kingdom)

This case involves motorist Bill Roe who was seriously hurt in an accident in 1996, when his car allegedly skidded on tram tracks in Sheffield. An Appeal Court ruling opened the way for Mr. Roe to seek substantial damages from Sheffield City Council and the operators and constructors of the Supertram system.

Some of the facts from the legal proceedings undertaken to date and summarised in the Approved Judgement by Lord Justice Kennedy at the Court of Appeal on 23 March 2004 are:

i. The accident has been found to be wholly caused by the state of the road on which the claimant was travelling.

ii. The road is a dual carriageway with a 40mph speed limit.

iii. The tramway is located in the outer lane of the highway.

iv. The accident occurred on a left hand bend and Mr. Roe’s vehicle collided with a post in the central reservation.

v. The upper surface of the offside rail was some 4-10mm proud of adjoining concrete. Police evidence stated that the construction of a radial tyre was such that once supported on a proud rail there could not be contact with the road surface through "droop" on either side of the rail.

vi. The nearside rails better approximated the concrete in height although in one location it was also 4mm proud of the adjoining concrete.

vii. The road was wet.
B1.2 Pictograms

Fahrradpiktogramme zwischen Straßenbahnschienen

Geschrieben von: VK
Mittwoch, den 18. Februar 2009 um 22:22 Uhr

Fahrräder und Straßenbahnen vertragen sich nicht - könnte man meinen. Viola haben Angst, mit dem Rad in die Schiene zu kommen oder auf dem Gleis der Straßenbahn eng überholt zu werden. Die Folge ist, dass viele Radfahrer sich rechts an den Bordstein bzw. an parkende Fahrzeuge drücken, was wiederum zu engen Überholabständen der Autos führt.

Gut, gegen Stürze in der Schiene kann man sich mit breiteren Räumen behelfen. Auf der Kaiserdammallee in Berlin wurde auch das andere Problem prägend und kreativ gelöst.

Im Abstand von etwa 20 Metern sind auf der Fahrbahn zwischen den Straßenbahnschienen Fahrradpiktogramme aufgebracht, die deutlich machen, dass Radfahrer hier nicht nur fahren dürfen, sondern ausdrücklich sollen.

Straßenbahn- und Autofahrer werden dadurch hingewiesen, dass Fahrräder auch Fahrzeuge sind und somit auf die Straße gehören. Radfahrer wiederum werden daran erinnert, dass sie nicht auf dem Bürgersteig fahren sollen.

Wann gibt es so etwas in Dresden?

kg / Foto: weinanchen / Flickr
B 4.8 Phoenix Profile Costs

The price indication for profile 1 and 2 on the drawing in the three qualities are:

**Price indication for SBR**

<table>
<thead>
<tr>
<th>Article</th>
<th>: Profile 1</th>
</tr>
</thead>
<tbody>
<tr>
<td>Dimension</td>
<td>: 130 x 172 x 1200 mm</td>
</tr>
<tr>
<td>Quality</td>
<td>: Rubber compound SBR with 20 % recycles rubber</td>
</tr>
<tr>
<td>Hardness</td>
<td>: 60 – 70 Shore</td>
</tr>
<tr>
<td>Quantity</td>
<td>: 835 pcs (1000 m single track)</td>
</tr>
<tr>
<td>Price indication</td>
<td>: € 119, 00 per piece</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Article</th>
<th>: Profile 2 with groove</th>
</tr>
</thead>
<tbody>
<tr>
<td>Dimension</td>
<td>: 130 x 172 x 1200 mm</td>
</tr>
<tr>
<td>Quality</td>
<td>: Rubber compound SBR with 20 % recycles rubber</td>
</tr>
<tr>
<td>Hardness</td>
<td>: 60 – 70 Shore</td>
</tr>
<tr>
<td>Quantity</td>
<td>: 835 pcs (1000 m single track)</td>
</tr>
<tr>
<td>Price indication</td>
<td>: € 115, 00 per piece</td>
</tr>
<tr>
<td>Mould costs</td>
<td>: € 20,000,00</td>
</tr>
</tbody>
</table>

**Price indication for EPDM**

<table>
<thead>
<tr>
<th>Article</th>
<th>: Profile 1</th>
</tr>
</thead>
<tbody>
<tr>
<td>Dimension</td>
<td>: 130 x 172 x 1200 mm</td>
</tr>
<tr>
<td>Quality</td>
<td>: EPDM</td>
</tr>
<tr>
<td>Hardness</td>
<td>: 70 Shores</td>
</tr>
<tr>
<td>Quantity</td>
<td>: 835 pcs (1000 m single track)</td>
</tr>
</tbody>
</table>
Price indication : € 189,00 per piece
Article : Profile 2 with groove
Dimension : 130 x 172 x 1200 mm
Quality : EPDM
Hardness : 70 Shore
Quantity : 835 pcs (1000 m single track)
Price indication : € 182,00 per piece
Mould costs : € 20,000

**Price indication for Recycled Rubber**

Article : Profile 1
Dimension : 130 x 172 x 1000 mm
Quality : 100 % recycled rubber bonded with polyurethane
Quantity : 1000 pcs (1000 m single track)
Price indication : € 42,00 per piece

Article : Profile 2 with groove
Dimension : 130 x 172 x 1000 mm
Quality : 100 % recycled rubber bonded with polyurethane
Quantity : 1000 pcs (1000 m single track)
Price indication : € 40,00 per piece
Mould costs : € 15,000

Payment : 30 Days, net
Delivery : ex works
Validity : 30 June 2012
Remark : The price of the base profile is not included