Tramway Infrastructure

In this section you will find guidance on the infrastructure of the tramway system including the identification of track, bridges, tunnels and other infrastructure.

The guidance below is in line with UK best practice:

The Track

Steel running rails should conform to the appropriate standards such as BS EN 14811 (Railway applications. Track. Special purpose rail. Grooved rails and associated construction profiles) or BS EN 13674 (Railway applications. Track. Rail. Switch and crossing rails used in conjunction with Vignole railway rails 46 kg/m and above). The rail section(s) and materials, and wheel profile(s) should be carefully selected so as to be mutually compatible in terms of derailment prevention, ride, noise, wear and adhesion.

Consideration will need to be given to adhesion levels achievable with new rails. Generally these levels should improve with use.

Magnetic properties of the rail will affect the performance of electromagnetic track brakes.

Grooved rails should have sufficient and suitable drainage provided at appropriate intervals and locations (such as areas of ponding, bottom of gradients). When laid in the highway they should be connected to surface water drainage systems which may have a significant effect on highway drainage.

The drains should be capable of being easily cleaned to allow removal of sand and other debris. The provision of drainage slots should not render the rail incapable of providing sufficient support or guidance for trams.

Where rails are laid in a carriageway that is used by rubber-tyred vehicles travelling on the same general alignment 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. It is particularly essential to consider the movement of two wheeled vehicles and cycles.

The track should be located within the carriageway so that, so far as is reasonably practicable, it does not coincide with the path normally taken by the wheels of rubber-tyred vehicles.

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

The carriageway incorporating the tramway should be engineered to present a surface which:

- can support the normal loads of vehicles using the carriageway, and

- has a seal to minimise the ingress of water at the interface between rail and adjacent road surfaces, where such ingress could cause damage to the highway surface.

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

In the case of integrated on-street tramways, so far as is technically feasible, the head of the rail should be level with the adjacent road surface when first laid.

Track Geometry

The maximum horizontal and vertical curvature, the maximum gradient, the maximum track twist on a tramway, and combinations thereof should be established taking account of the following (not exclusively):

- physical constraints of any route
- capability of the tram, and
- effects of speed, curvature and gradient on the passengers.

The horizontal curvature of sections of the tramway should be designed with the highest radius possible and appropriate mitigation in place for any consequence of flange climb, overspeed derailment or overturning. Any mitigation should consider as a minimum the following (not exclusively):

- advance warning signs and speed limit warnings as defined in **TRSGD**
- avoidance of lineside equipment boxes, drainage inspection covers etc. in the vicinity of curves, and
- provision of automatic speed control.

Geometric limits should not be set too severely on the infrastructure as they may create restrictions on the types of trams that can operate over the whole route / network.

Where circumstances permit, super elevation (cant) should be provided on the tram track and the cross section of the highway should be designed to accommodate this.

There must also be consideration of whether surface water drainage can be directed away from the grooves in the rails by providing a cross-fall.

Tramway Points in the Highway

Points should not be located where the movement of the blades would cause a hazard to other road users including cyclists and pedestrians, or where road vehicles could damage the points.

The moving blades of the points should not normally be located at the following locations:

- at places in the street where there are concentrations of pedestrians, such as at:
- formally identified tramway / highway crossings
- where there would be a particular danger to pedestrians, cyclists or motorcyclists, or
- in busy traffic, or where traffic lanes cross or merge with a tram lane, particularly where this is also aggravated by a turning movement.

Pre-sorting points with interlaced track or double-headed rails or other techniques may be used where practicable to avoid hazards to other road users.

Where points have to be located at the more hazardous locations identified above, special precautions may be necessary to minimise risk see the Control and Movement section **here** and **here.**

The point indicator and point detection circuits should be designed to meet inherently fail safe criteria where a point indicator is the primary means used to allow a tram to approach facing points at a speed higher than that which would allow the driver to observe the lie of the points, and stop in advance of an incorrectly set route or misaligned point blade.

There should be an additional indication for an out of correspondence point condition (where the point blades are not in the position selected to allow a safe tram movement) which should be a horizontal bar. UK tramways use bespoke point indications that are not a prescribed form; see standardised European point indication diagrams **here.**

If point blades are misaligned or an incorrect route is set, a tram that cannot proceed should not obstruct other trams (other than a following tram) or other road traffic. Where the points are some distance beyond the road junction, a suggested appropriate arrangement is shown **here**.

Where points are located in off-street sections of the tramway, provision should be made to deter access to those areas where the moveable portion of the points would cause a hazard. Sprung points should be used where possible.

Bridges and Viaducts

Bridges Carrying the Tramway

Bridges or viaducts carrying tramways should be designed using appropriate methods and loading assumptions, including for other road vehicles as appropriate.

Designers who choose to follow the Eurocode process should note that the standard load models in **BS EN 1991-2, Actions on structures - Part 2: Traffic loads on bridges,** are all for railway cases and are unlikely to be suitable for the lower static and dynamic loads generated by trams without some modification. If a standard BS EN 1991-2 load case is used, then a suitably justified use of a reduced factor α will be necessary.

Adequate derailment containment should be assessed and sufficiently provided on all bridges and structures.

Bridges Over the Tramway

Bridge parapets should be adequate to prevent access to the live overhead electrical traction power system.

Bridges and supporting structures over the tramway should be capable of resisting credible impact forces from derailed trams. Designers should be able to demonstrate that they have used risk based kinetic energy values in developing the design.

Tunnels

Lighting in underpasses and tunnels should be provided when either side is not already lit by street lighting. This is in addition to the provision of lighting for use on an emergency basis for evacuation, which may also assist maintenance of the tramway.

If the tunnel is shared with other traffic of any kind, then it should meet current highway design standards.

Where the tunnel is for tram use only and other road or railway users are excluded, then the design of the tunnel should reflect the assessment of the tramway hazards as the risk profile is likely to be lower.

Where a new twin-track tramway tunnel is constructed, then this should be designed to provide side walkways of at least 700 mm width. If this is not possible for existing tunnels, then a walkway as wide as reasonably practicable should be provided. Operational procedures may be required to allow safe egress from a dead tram within a tunnel.

For new or existing single-bore tunnels, a side walkway of 700 mm minimum should be provided with additional space on the opposite side of the tram of at least 460 mm to allow staff access.

Where former railway tunnels are used, if it is not possible to provide adequate walkways on both sides, the space should be used to provide one centre walkway with a generous width.

Where the size of a former railway tunnel does not allow for any walkway to be provided, then the track may be used as a walkway only if the following can all be adequately provided:

- there is sufficient clearance for the tram doors to open and allow passenger egress
- the track provides an acceptable walking surface
- the tunnel is illuminated, and
- the tramway operates on line of sight through the tunnel.

If all of the above conditions cannot be met, the operator will need to ensure that the findings of a thorough risk assessment are reflected in the SMS and operational controls.

Tramway Access Control

A tramway that is operating on line of sight principles generally has no restriction on access to it for pedestrians. However, where there is the potential for particular risks to occur or sightlines / sighting times are restricted, then a risk assessment should be undertaken to select appropriate deterrent measures and other measures such as speed limits and lighting etc.

Of particular importance is the prohibition and protection of unauthorised people from the electric traction system. Such preventative and protective measures should be designed with the needs of the particular environment (and therefore risks) in mind. For further information see under Tramway Access Control in the Electric Traction Systems section **here.**

The design of the tracks, paving, OHLE and other infrastructure associated with the tramway should take account of the needs and safety of pedestrians, cyclists and other highway users, and in doing so, make appropriate provision for their safety.

While the tramway is normally unfenced, in some locations fencing or other barrier may be required to segregate or direct pedestrians away from it, or to prevent access to it, whilst also accommodating desire lines for pedestrians and cyclists.

Special consideration should be given to the needs of mobility-impaired people, whether on foot or in wheelchairs, or using pushchairs. As suggested above for cycle groups, there may be local groups who may be able to provide useful information and feedback on the most effective measures or solutions for the tramway route under development.

Where the need for a segregated tramway has been established, deterrents to access should be provided to discourage trespass by both pedestrians and road vehicles. Promoters should include suitable powers within the TWA Order to provide for enforcement for trespass.

Identification of the Infrastructure

A means of identifying any location or structure along the tramway should be produced, for example, by numbering the overhead line supports.

All bridges and other fixed structures, as appropriate, should be uniquely and conspicuously identified.

Any system of identification should be consistent with that of the local Highway Authority.

Terminating Tracks

Where tram tracks terminate, arrangements should be made for any potential tram that overrun the normal limit of operations to be brought to a halt or contained safely. The arrangements may include (not exclusively):

- sand drags
- soft macadam surfacing over the rails, or
- energy-absorbing architectural features such as large planters, etc

The selection of the arrangements for a location should be on the basis of tram kinetic energy, the risks arising from an overrun, and suitability for the surrounding environment. The means chosen should discourage pedestrians from lingering in an overrun area.

Without proper consideration of energy absorption rates the provision of buffer stops could increase risk.