

Bus Pedestrian Over-Running: From Problem to Solution

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An earlier paper address the threat posed to pedestrians from poor bus frontal conspicuity, and proposes remedies for this problem.¹

But poor conspicuity is not the only danger posed to pedestrians by buses. In addition, there is the risk of over-running due to the fact that the front, and body, of the bus are just far enough off the ground for pedestrians to pass underneath and be run over by the wheels of the bus.

This problem generally does not exist with modern trams (UK) or streetcars (US), which often have bodywork skirts that extend to within a few centimetres of the street surface. Older heritage trams generally have the same kinds of skirt on the sides, combined with either a 'cow catcher' on the front or else, some kind of actively triggered system in which the collision of a person with a guard rail trips the fall of a basket just in front of the wheels. Some of these systems are simple, others more elaborate, and yet modern buses have nothing like them.

This paper addresses the issue of pedestrian over-run protection for buses and whether something similar to the degree of protection afforded by trams can also be achieved with buses. The benefits to pedestrians in this context also extend to cyclists and motorcyclists, who are also frequently put at risk of being run over by collision with buses.

Why do buses lack pedestrian over-run protection?

Why do buses lack pedestrian over-run protection, of the kind that is standard on trams? One reason is that there is a misplaced confidence in the ability of the bus to stop more quickly than the tram. It is certainly true that buses can stop more quickly than old-fashioned trams, though the difference with modern trams is less pronounced. But in any case, we may indeed term this confidence misplaced, because it doesn't seem to stop the

¹ Christopher E. Harris, 'Bus Frontal Conspicuity: From Problem to Solution' (2011).

bus from actually hitting pedestrians, as we see in practice in Wellington and other cities. It is also true that some of the most serious accidents have occurred when pedestrians have been dragged under the bus and the driver has not been aware of this, generally at low speeds and at crowded bus stops.

A second reason is that a high ground clearance enables buses to travel on roads of poorer quality and more uneven surface than the generally very smooth track-bed on which trams run.

The third and perhaps most subtle reason is that a high ground clearance facilitates ‘frontswing’ and ‘tailswing’; that is to say, the ability of part of the body of a bus to pass over the roadside kerb when the bus is coming into a bus stop, or pulling out of a bus stop, at an angle. This problem is made worse by the fact that buses generally have two sets of wheels with a body that greatly overhangs the front and rear wheels alike in order to even out the weight, whereas trams tend to have more sets of wheels, closer to the front and rear. Trams, of course, typically run in the middle of the road, and they are also incapable of deviating from the tracks. The tram exhibits a tiny amount of frontswing and tailswing as it goes around corners—this is unavoidable—but the question of a serious collision with the kerb due to frontswing and tailswing simply does not arise with trams.

Ironically, only the corners of the bus actually swing over the kerb. But the same clearance is sustained all around the bus generally, in ways that allow pedestrians to be dragged under the bus and run over by the wheels.

In general we may say that a high and unguarded bus ground clearance sacrifices pedestrian safety to a degree of ‘rough road capability’ that may not be needed in practice. Even if it is needed, it is surely not too difficult to design an adequate pedestrian guard system. This would be most needed on the front, though it should also guard the rear wheels.

Images and advantages of a pedestrian over-run guard system

A version of the triptych shown in the earlier ‘Bus Frontal Conspicuity’ paper is shown overleaf. As with the original version, the left-most image in the triptych shows a standard Wellington bus in a blue shadow.

The central image in the triptych shows a standard Wellington bus with enhanced frontal conspicuity. It is the same as the image on the right of the triptych in the earlier paper.

The image on the right of the triptych in this paper shows a standard Wellington bus with enhanced frontal conspicuity and an over-run protection guard.



The guard consists of two parts, a static guard above and a dynamic guard below. The dynamic guard retracts into the static guard should the road surface rise relative to the bus (e.g. arriving at the foot of a steep hill, ‘kneeling’, or braking hard.) The guard is tapered toward in the front, allowing frontswing, and then widens out toward the front wheels, so that it is impossible for any person to roll under the front wheels. Strictly speaking it only needs to be tapered on the left; a reduced or absent taper on the right would be desirable to prevent anyone who is run over from being pushed out to the right, into live traffic. From most angles this asymmetry will not be apparent given that the guards screen the front wheels from both sides. This will be especially true if the corners of the guards are curved.

The static guard is fixed in position relative to the rest of the bus, though it may be spring-mounted to minimise damage in the event that the dynamic guard cannot retract enough to prevent ground contact.

The dynamic guard may rise into the static guard passively, through contact with the road at low speeds or on rare occasions, or else it may be dynamically retracted using a sensor system and electromagnetic actuation.²

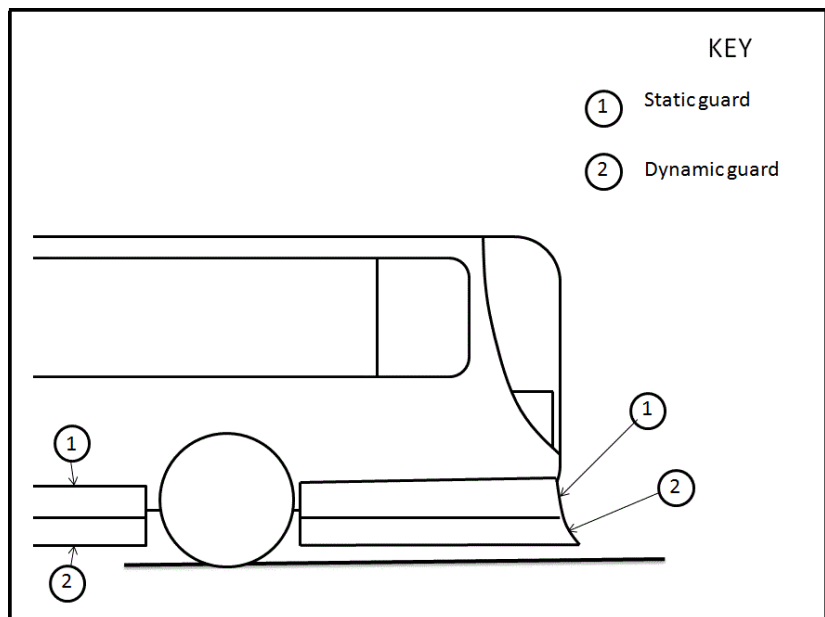
In addition to the direct safety benefit of the guard, an *indirect* safety benefit of an over-run guard system is that it will further enhance bus conspicuity. This is apparent in the triptych, above.

Advantages of also guarding the rear wheels

The image below and to the right shows the front of a bus with guards that protect the front (facing to the right) plus a continuation of the guards past the front wheels, to guard the rear wheels from anyone who might be trapped behind the front wheels but before the rear wheels. In practice the people most likely to be affected in this way are cyclists and those who board or exit through the rear doors.

The guards may also extend behind the rear wheels, to protect anyone who might slide under the back of the bus, or be affected by bus reversing.

Guarding the rear wheels has direct safety benefits for those who might fall under the rear wheels, clearly enough.



But also, it has a further advantage in that, if the rear wheels are guarded, this will allow pedestrians, including school pupils, to enter as well as exit safely through the rear doors, in ways that will have very considerable advantages for passenger convenience, boarding time, and the reduction of the humiliating experience of standing in a queue. The bus riding experience will become more tram-like, in that regard.

² Provisional patent protection has been undertaken for certain of the details of how a dynamic guard system would be realised.

So there are considerable operational benefits to be gained from developing a comprehensive over-run guard system, as well as direct safety benefits.

What needs to be done next

It is entirely unclear how large the static guard might reasonably be before it starts to risk regular collision with the ground. It is also unclear how often the bus does actually nose down in ways that would require a dynamic guard to retract, and how fast it might be going when this happens.

To effect the proper design of a guard system, and to address the question of whether passive retraction will do, or whether an active system with sensors and actuators is needed, it is necessary to instrument a bus and measure actual ground clearance changes, including the speeds at which they occur.

Further applications

It should be readily apparent that a system such as this could also have safety implications for trucks and all other heavy vehicles, including heavy trailers. For trucks, it would probably even reduce fuel consumption by lowering wind resistance, in addition to improving safety. For trucks and heavy trailers, it is mostly cyclists and and motorcyclists, rather than pedestrians, who are at risk, among vulnerable road users. For trucks and heavy trailers, the static guard should also be made strong enough to resist *under-running* by motor vehicles of all kinds, as the deck of a truck or heavy trailer is often high enough to permit this to happen.

Keywords

Conspicuity, urban bus, pedestrian, over-running, under-running, cycle safety, motorcycle safety

Note on background literature

There is no technical literature, as far as I am aware, on bus pedestrian over-run protection or lack thereof, and its potential role in pedestrian accidents. In the absence of evidence to the contrary, the findings of this paper should therefore be regarded as novel and, at the same time, a 'first draft' with potential for rapid improvement, both as regards problem analysis and proposed solution.

There is an extensive literature on the under-running of trucks and heavy trailers by other, smaller motor vehicles and many countries require that trucks and trailers be guarded to prevent this from happening, though not New Zealand.

Author biography

Christopher E. (Chris) Harris has a PhD in planning from the University of Auckland. His first degree was in mechanical engineering. Chris has worked in the area of urban public transport for a number of years and has a wide range of publications on more advanced and historical topics, including a forthcoming book.