

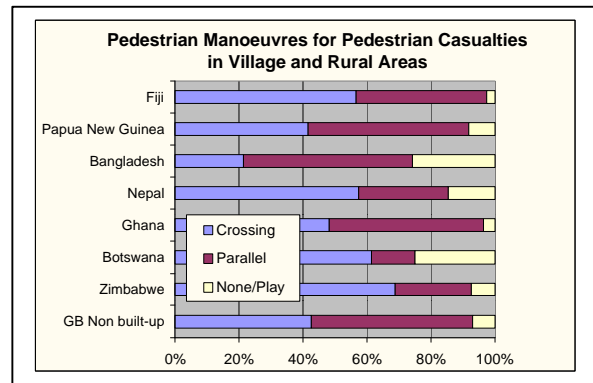
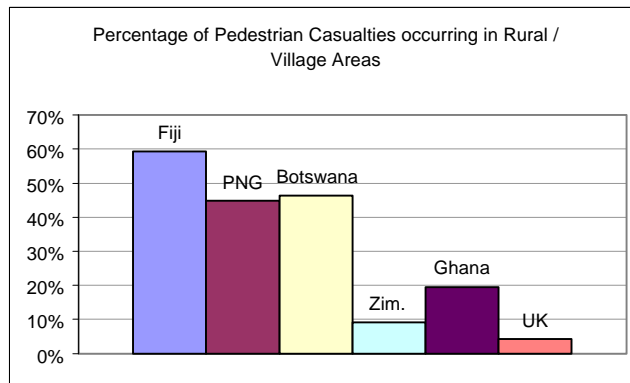


Vulnerable Road Users



The Problem:

In many countries, high volumes of pedestrians, cyclists and other vulnerable road users have little choice but to travel along roads in close proximity to fast vehicles. As a consequence, many vulnerable road users are put in a high risk situation, which inevitably leads to large numbers of pedestrian and vulnerable user accidents.



A fundamental problem is that the traffic survey, which forms the basis of highway improvement schemes in developing countries, rarely includes counts of pedestrian and slow moving traffic movements. This can result in the planners and engineers not incorporating measures for these vulnerable users. The problem is further aggravated by the poor vehicle maintenance or the condition and skill of the driver himself. Whilst all these factors need to be tackled, much can be done to improve the road design so that vulnerable road users can interact in a safe manner with the faster more motorised traffic. The World Bank and other aid agencies are now more aware of these problems and are beginning to demand safety audits of new and improved routes that address the needs of all users.

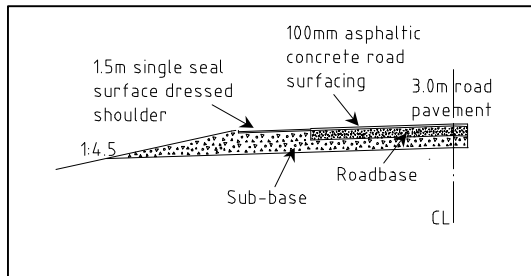
The Solution:

Purely from a road safety point of view, the ideal solution is:

- To provide a wide flat area for slower moving traffic and pedestrians, ideally 1.5 metres wide. If a wider area is provided this must include good physical and/or aural delineation to deter drivers from increasing their speed through the wide sections.
- To provide segregated paths that track the road alignment and do not deviate too far from the road edge.
- To design and maintain paths to a high enough standard to attract the vulnerable road users away from the smooth road surface, ideally by providing a sealed surface.
- To locate the paths in a safe location, usually outside of the recovery zone for the motorised road users.
- To inform pedestrians and other road users of the safest way to travel along the road, by using signs to highlight access to segregated footpaths or by warning drivers of pedestrians walking on the shoulder.

Such paths, from the highway designer's point of view, will generally, but not always, increase the construction costs. A number of low-cost solutions to the problem of slow moving road users have evolved, some as a positive side effect of a particular construction technique adopted by the highway engineer. **Thus, it is apparent that certain highway designs can be implemented at low-cost and are inherently safer than others.**

Shoulders as Footpaths:



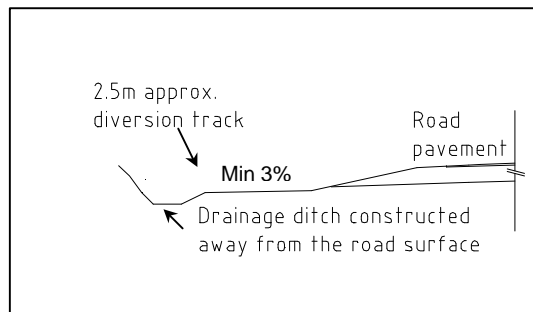
Cost 🟡🟡🟡
Safety ★★

The sealed shoulder is often adopted for road maintenance purposes but it also provides a very acceptable surface for walking or cycling. Experience in Tanzania indicates that pedestrians find it very difficult to use 0.5m shoulders whereas they behave in a completely relaxed manner on shoulders 1.5m wide. The intermediate width of 1.0m shoulder width is a common standard in many countries, but it is also an uneasy width for pedestrians to use. Overlays of just the carriageway, producing a small step down to the shoulder, can have the positive side effect of enhancing the segregation of the shoulder; however, the step should be minimal or motorcyclists and bicyclists could lose control if they accidentally traverse the edge and, if very severe could even lead to poorly loaded lorries rolling over. A thick thermoplastic edge line is preferable to an edge drop.

Safety Considerations

- The pavement should ideally be 1.5 metres wide to allow pedestrians to feel relaxed whilst using the footpath. The minimum width should be no less than 1 metre.
- The surface material chosen should try to differentiate the shoulder from the main running surface.
- The surface material should ideally be sealed to provide a smooth surface for pedestrians and cyclists.
- Where an overlay is present the edge should be chamfered to prevent loss of control by cyclists and other road users accidentally traversing it.

Diversion roads as Footpaths:



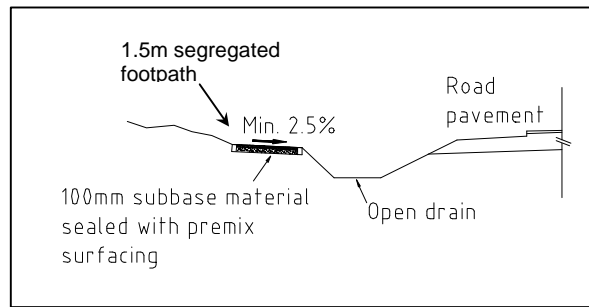
Cost 🟡🟡
Safety ★★★★★

The wide drainage ditches that evolved in countries such as Malawi from labour intensive construction techniques naturally leave segregated level "paths" that in the dry season are used by pedestrians, cyclists and other slow moving road users. In Malawi the flat, wide diversion road provided a good quality pedestrian footpath with little further engineering required. However, in Nepal an initial project to convert the diversion roads to footpaths found poor uptake, largely because the design hugged the terrain and consequently incorporated short sections of steep gradient and long deviations from the road corridor. Uptake of the footpaths was improved by limiting the access slopes to a maximum 4% gradient, following the road alignment much more rigidly and undertaking a publicity campaign in the local villages.

Safety Considerations

- The pavement surface should be engineered to shed water into natural drainage courses and preferably designed with an all-weather surface.
- The diversion width should be a minimum of 1.5m but a width of 3m will provide access for animal-drawn vehicles.
- Access points to the road should be maintained at regular intervals and have a maximum gradient of 4%.
- The diversion route should follow the road alignment as closely as possible.
- Signing and publicity campaigns may help increase uptake.

Segregated Footpaths:



Cost 🚩🚩🚩🚩
Safety ★★★★★

Segregated footpaths offer the safest option for pedestrians travelling along a rural road. In this case the footpath is separated from the running surface by a physical feature, such as the embankment slope; or alternatively, the footpath may abut the running surface but be segregated by a barrier kerb or a significant step in height protected by a kerb. The choice of footpath is dependent on the number of pedestrians using the road and the surrounding terrain. An advantage of segregated footpaths is that they can be constructed at the foot of the road embankment thereby removing the need to widen the road embankment, leading to lower construction costs.

Safety Considerations

- The footpath should ideally be 1.5 metres wide.
- The footpath should have low gradients, preferably less than 4% to encourage uptake by cyclists and other slow-moving traffic.
- The footpath should be sealed to provide an all-weather surface, comparable with the road surface.
- The footpath should track the road alignment as closely as possible.
- Shade trees planted alongside the route may encourage uptake.

Case Study: Nepal

Footpaths were constructed on the Biratnagar – Itahari Road in Nepal as a result of a collaboration between the Nepal Department of Roads, the Department for International Development, Roughtons International and TRL.

1. The problem



1. High volumes of pedestrians travel to and from factories along the road.

2. Planning



2. A trial footpath was planned along the section of road carrying the heaviest pedestrian flows. This location had a wide grassy area between the road and existing drainage channel.

3. Review



3. The initial low design standard led to the footpath being ignored by the pedestrians, despite the benefits of safety and shade. Education programmes were carried out to encourage use but the presence of snakes in the trees and excreta were mentioned as reasons for not using the footpath.

4. Construction



4. The footpath was upgraded to a 1.5m wide sealed surface. The improved quality of construction led to increased use of the footpath without the need for any publicity. The use of small-size aggregate (some using recycled road material) encouraged more pedestrian and cyclist usage due to its smooth surface; and benching the path into the embankment prevented the path being affected by flooding (see centre photograph below).

Cycle Lanes and Cycle Paths



In developing and some developed countries bicycles and other slow-moving vehicles are generally expected to use the road rather than have a separate running surface. However, the differential in speed between these vehicles and motorised vehicles can be so large that as cycle flows and traffic flows increase there is an increased risk of cyclists being involved in accidents. Cyclists also feel intimidated by motor vehicles overtaking too close.

In countries with significant levels of cycle traffic, benefits can accrue from constructing a special lane or path for cyclists to use. Thus in rural areas where the Annual Average Daily Cycle Flows exceeds 200, consideration should be given to the provision of a cycle track link. The lowest cost solutions divide either the footpath or the road pavement into two lanes for combined use by pedestrians/cyclists or motorists/cyclists. The cycle paths should be clearly marked at regular intervals with a cycle or pedestrian symbol.

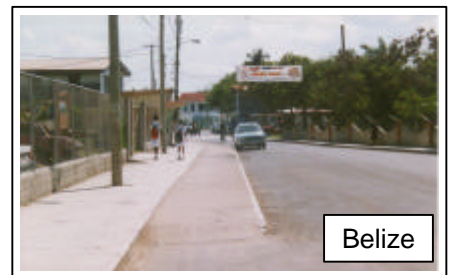
Standard	Width (m)	Comments
Maximum Width	2.5	Lanes of this width may be used where cycle flows are expected to be in excess of 150cycles/peak hour. Lanes should be mandatory in order to avoid intrusion by motorists. A segregated facility may be preferred as an alternative.
Desirable Minimum Width	2.0	Enables the cyclist to safely pass other cyclists within the cycle lane.
Absolute Minimum Width	1.5	Enables the cyclist to avoid the majority of obstructions found adjacent to a kerb; for example debris and gullies.
Limiting Width	1.2	Widths down to 1.2m may be valuable in specific circumstances where available width is restricted; for example, where queuing traffic blocks the cyclists' route to an advanced stopline. Where applied, the lane should normally be identified by a coloured surface to increase effective width in urban areas.

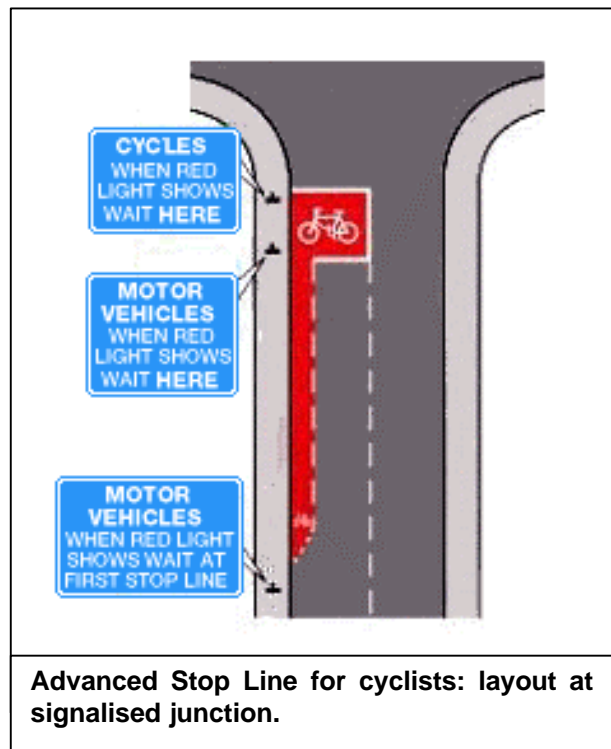
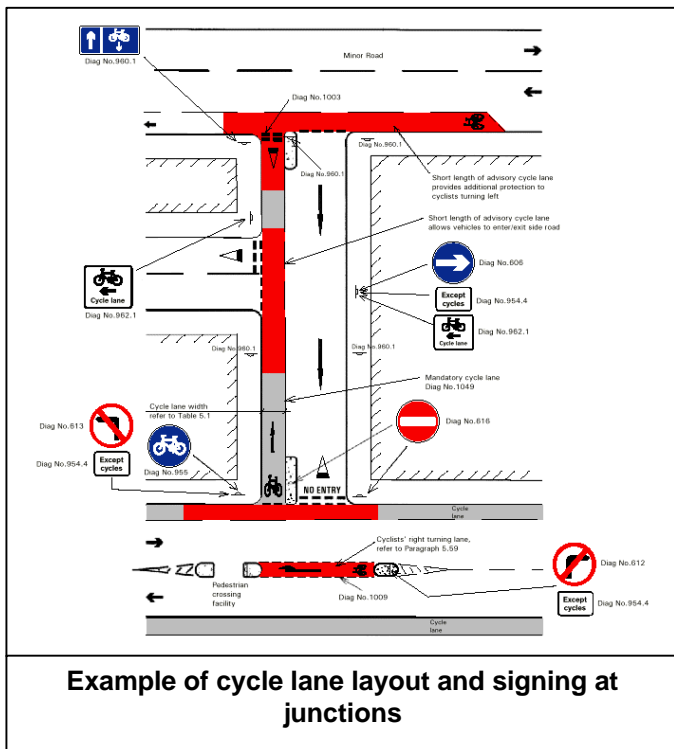
When the cycle flow increases significantly, a better alternative is to segregate the cycle lane from the footpath. In Belize the existing footpath was extended to provide a cycle lane. Care should be taken to inform drivers and cyclists of the end of the cycle lanes and provide clear priority for cyclists joining or crossing the main traffic stream.

Problems often exist at narrow bridges, which tend not to get widened during major road upgrading which includes widening. This can lead to pedestrians or rick-shaws etc getting squeezed by faster-moving vehicles, often with fatal consequences. Solutions include canti-levered special footways, narrowing the carriageway on one side to provide a cycle lane across the bridge, or speed reducing measures like humps or jiggle bars on the approach to the bridge.

Care needs to be taken in dealing with cycle paths or lanes at junctions. For example:

- roundabouts should have 'tight geometry' (i.e. arms that are tangential to the roundabout centre; single lane entry; minimal flare; 15-25m island diameter and external diameter of 25-35m; and circulatory carriageway of 5-7m); and
 - advanced stop lines should be installed at signals where there are significant turning flows (see diagram below).





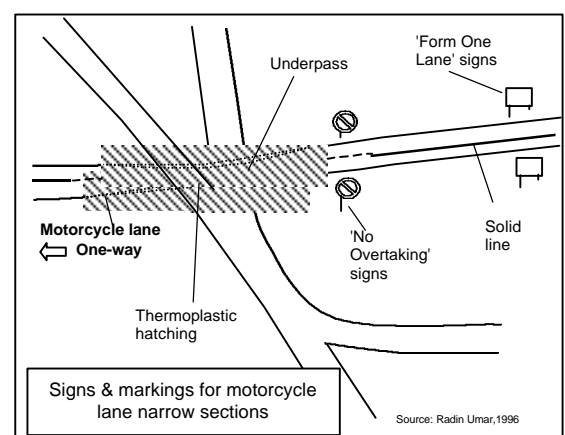
Motor Cycle Lanes

Although not as slow-moving, motor cyclists are also a very vulnerable group of road users, which when combined with their high speed results in very high casualty rates.

In some countries in south-east Asia motorcycle use is very high; for example, in Malaysia the proportion of motorcycles on the road varies between 35 to 75% of the traffic (Radin Umar and Barton, 1997), and consequently accidents involving this road user group are found to be proportionately high (55% of all casualties). Malaysia has pioneered motor-cycle lanes and here the high cost of constructing such dedicated lanes, estimated to be about US\$200,000 per km, might well be justified. For the very high flows experienced along a major arterial road from the capital city where the average annual daily traffic is as high as 200,000 vehicles, motorcycle accidents have been shown to reduce by about 39% since the lane was introduced, yielding a particularly good benefit to cost ratio of 3.3.

However, great care needs to be taken in designing such lanes as research suggests that collisions between motorcycles themselves within these lanes might still be high unless certain minimum design standards are maintained. These include:

- Maintaining sight distances.
- Adequate horizontal and vertical curvature for the design speed.
- A minimum lane width (in one direction) of 1.8m (3.6m to permit overtaking).
- The crash barrier support posts facing the lane are protected.
- An appropriate centre line marking should be provided in 3.5m or wider lanes.
- Where the geometry necessitates reduced visibility or reduced lane width (less than 3.2m), 'No overtaking' and 'Form one lane' signs are strongly recommended.



Research evidence

PNG Highlands Highway Footpath Study:

The following table shows the results of a TRL study on the impact on safety of constructing 10 km of footpath alongside the Highlands (Okuk) Highway in Papua New Guinea. Where no footpath was constructed, pedestrian casualties of all types rose, but for the sections where a footpath was constructed, casualties were reduced significantly, with a very high First Year Rate of Return achieved. The footpath was constructed along an 8 km stretch at Goroka and for 2 km at Mt Hagen.

Pedestrian accidents for pedestrians walking along the road, on the edge or on the footpath (excludes pedestrians crossing the road or playing in the road)			
Severity Type	86-88 No footpath	89-91 Partially Completed	92-94 Footpath Completed
Fatal	9	9	6
Hospital	10	6	2
Not-Hospital	5	1	1
Damage	0	0	0
TOTAL	24	16	9

Comparison of Ch.86-88 km (No footpath) with Ch.92-94 km (Footpath completed)			
	Total accidents saved / year	Unit Cost (Kina)	Cost saving / year / km
Fatal	1.00	37225	3723
Hospital	2.67	9680	2581
Not-Hosp.	1.33	3020	403
Total saving/km/yr			6707

The First Year Rate of Return was calculated using the above savings/year/km as an estimate of the effectiveness of the measures.

	Kina
Cost /km	600-1800
Savings/year/km	6700
First year Rate of Return	400-1000%

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Zegeer C V, Reinfurt D W, Hunter W W, Hummer J, Stewart R and Herf L (1988) *Accident effects of sideslope and other roadside features on two-lane roads.* Transportation Research record 1195. TRB Washington.

CaSE Design:

The purpose of this project is to identify highway engineering designs that are inherently safe and that fulfil their engineering function at little or no extra cost to alternative designs. It is also concerned with the challenge of making low-cost engineering designs as safe as possible at minimum additional cost. If you have any suggestions for such designs or have comments on this CaSE Note, please contact Stephanie Kirk, Brian Hills or Chris Baguley at International Division, Transport Research Laboratory, Old Wokingham Road, Berkshire, UK RG45 6AU.

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Cost and Safety Efficient Design
for rural highways in Developing Countries

