ROAD SAFETY ENGINEERING TOOLKIT

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Abstract

The Austroads Road Safety Engineering Toolkit is a free, on-line reference tool created for road infrastructure and road services practitioners. It draws together the wealth of road safety engineering knowledge, including the latest solutions adopted by various Australian and New Zealand jurisdictions. The Toolkit has been put together with state and local government road authorities in mind, where staff need easy and quick access to information on crashes and road safety deficiencies.

The Toolkit outlines the best-practice, low cost, high return road safety engineering treatments to achieve a reduction in the number and the risk of crashes.

Provision of safer roads and roadsides is a major area of gain under the National Road Safety Strategy 2001–2010, which aims to reduce the number of fatalities per 100,000 population by 40% by 2010. This aim has been backed by Austroads funded research reviews, which have been used to provide up-to-date information contained in the Toolkit.

The Toolkit may be a useful tool in preparing Black Spot Program funding applications, provision of general advice to public and in community consultation. It provides assistance in crash site analysis and in the treatment selection. It also assists in the treatment of road locations, where high risk of crashes has been identified by public, practitioners or road safety audits.

The Toolkit can be found at: www.engtoolkit.com.au

Introduction

Reduction of crashes involving road environment factors is a major area of gain under the National Road Safety Strategy 2003–2010 and an Austroads strategic priority research area.

A challenge faced by Austroads member agencies and local governments is ensuring that decisions regarding road environment safety treatments are sound and will result in the most cost effective safety outcome. The Road Safety Engineering Toolkit (the 'Toolkit') is the only stand-alone product in the Australasian context which succinctly outlines low cost, high return treatments which can be easily implemented to address crashes and safety deficiencies.

A number of existing technical documents advise on various aspects of road safety management, including the design of engineering measures and schemes. This project draws together that existing advice as far as possible into one document, and updates it based on the recent experience of local and state government agencies, and on the Road Safety Engineering Risk Assessment research results.

The Road Safety Engineering Toolkit is free to use and can be found at: www.engtoolkit.com.au

The Toolkit is intended for road practitioners of all types and levels of professional experience, including: traffic and transport engineers, road maintenance engineers, asset managers, town planners, landscape architects, civil designers and community road safety officers. The Toolkit is intended to provide fundamental information regarding crashes and road features to suit those with less road safety experience, while detailed referencing of technical texts and new treatments will be of interest to more experienced practitioners.

The structure of the Toolkit allows practitioners to approach a given road safety problem from two distinctive angles: crash problem investigation and a road safety deficiency issue. Either way, practitioners are presented with a selection of treatments most likely to address the particular safety problem at hand.

Although the primary objective of this Toolkit is to focus on engineering-based treatments, the document also takes a holistic view on road safety, identifying issues such as enforcement, road user education and media campaigns.

The Toolkit has been developed progressively since 2004. This Toolkit is a 'living' document; it is intended to be maintained and updated regularly, so that new successful safety solutions can be captured and disseminated to practitioners. It is undergoing further development in 2007-08 financial year with content expansion and new features.

Toolkit

The current structure of the Toolkit is shown schematically in Figure 1. This structure has a two-dimensional approach to road safety problem analysis and treatment selection, as identified by the initial consultation with Austroads stakeholders and practitioners in 2004-05. The structure has evolved from these original concepts to provide more clarity in the use of the Toolkit. A third analytical approach, by road user, is being developed during 2007-08.

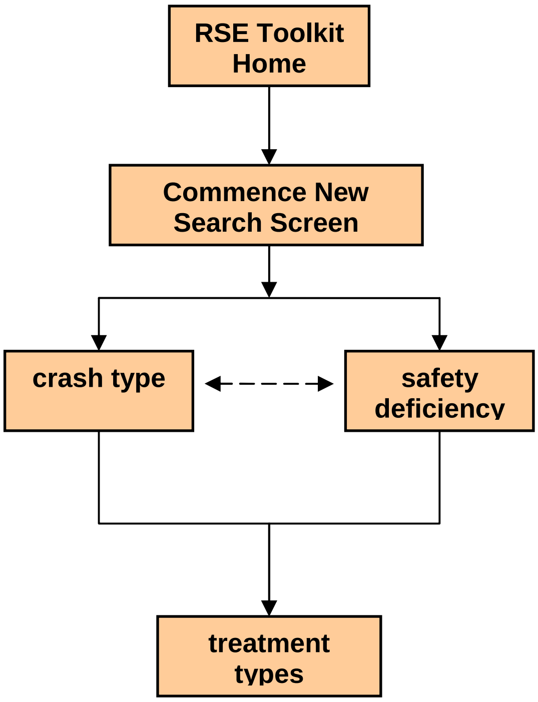
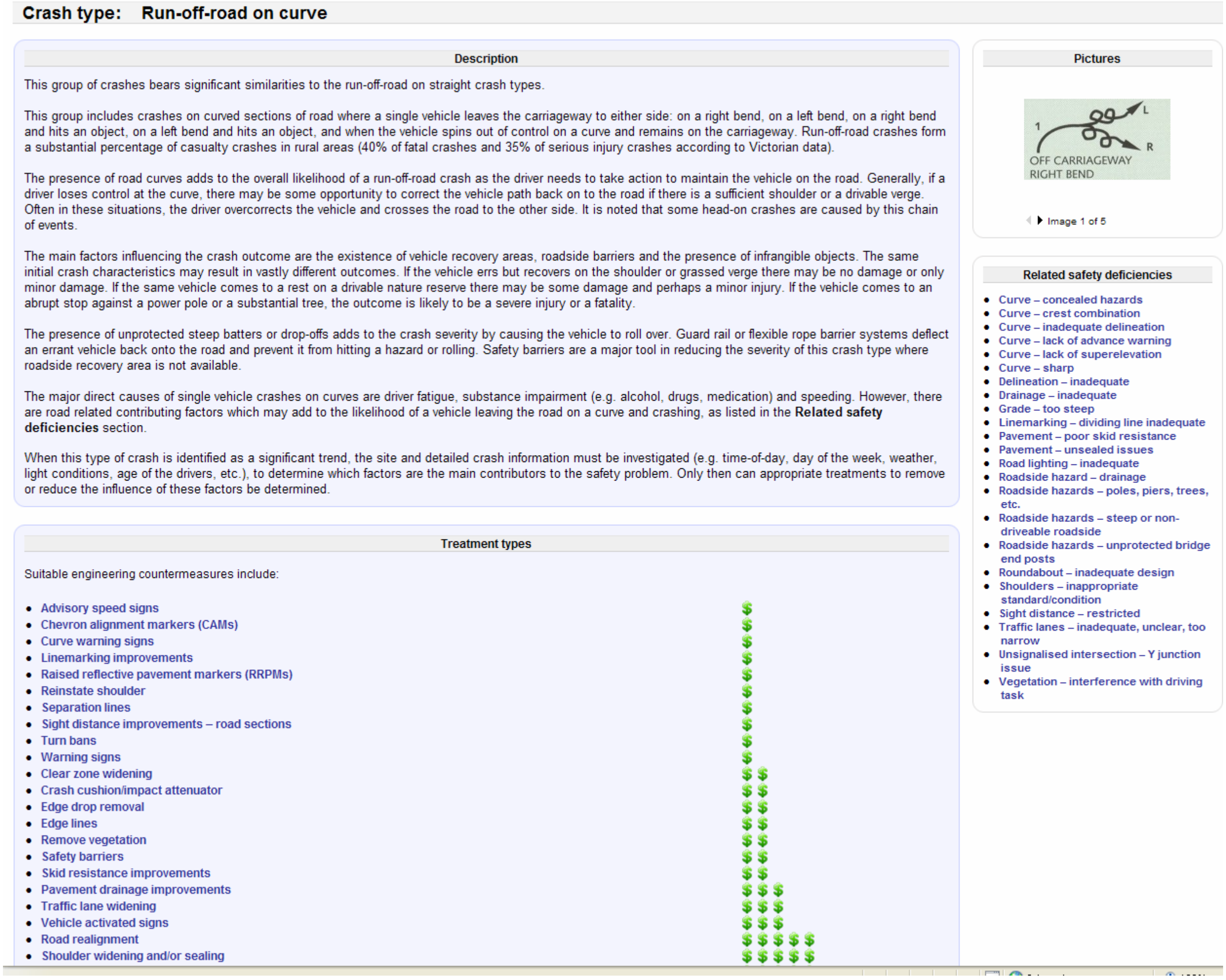


Figure 1 – Toolkit Structure

Thus, the user may follow the conventional black spot analysis approach by selecting the dominant crash types found at a site and exploring the information until the most appropriate treatment type for that crash type is identified. The treatment types relevant to the given crash type are listed in order of ascending cost (per typical site). Figure 2 shows a crash type scree layout.

There are 17 different crash types listed and described in the Toolkit. The types broadly follow the DCA/RUM groupings used by all Australasian jurisdictions. Each crash type provides a brief description of the crashes included in the type, discussion on the kinetics involved, the main contributing human factors and factors influencing the crash severity. There is also a listing of most common road-related deficiencies contributing to a given crash type. The user may decide to explore these deficiencies in more detail or to proceed directly to the listing of treatment types likely to reduce the frequency and severity of the crash type.



Crash type: Run-off-road on curve

Description

This group of crashes bears significant similarities to the run-off-road on straight crash types.

This group includes crashes on curved sections of road where a single vehicle leaves the carriageway to either side: on a right bend, on a left bend, on a right bend and hits an object, on a left bend and hits an object, and when the vehicle spins out of control on a curve and remains on the carriageway. Run-off-road crashes form a substantial percentage of casualty crashes in rural areas (40% of fatal crashes and 35% of serious injury crashes according to Victorian data).

The presence of road curves adds to the overall likelihood of a run-off-road crash as the driver needs to take action to maintain the vehicle on the road. Generally, if a driver loses control at the curve, there may be some opportunity to correct the vehicle path back on to the road if there is a sufficient shoulder or a drivable verge. Often in these situations, the driver overcorrects the vehicle and crosses the road to the other side. It is noted that some head-on crashes are caused by this chain of events.

The main factors influencing the crash outcome are the existence of vehicle recovery areas, roadside barriers and the presence of infrangible objects. The same initial crash characteristics may result in vastly different outcomes. If the vehicle errs but recovers on the shoulder or grassed verge there may be no damage or only minor damage. If the same vehicle comes to a rest on a drivable nature reserve there may be some damage and perhaps a minor injury. If the vehicle comes to an abrupt stop against a power pole or a substantial tree, the outcome is likely to be a severe injury or a fatality.

The presence of unprotected steep batters or drop-offs adds to the crash severity by causing the vehicle to roll over. Guard rail or flexible rope barrier systems deflect an errant vehicle back onto the road and prevent it from hitting a hazard or rolling. Safety barriers are a major tool in reducing the severity of this crash type where roadside recovery area is not available.

The major direct causes of single vehicle crashes on curves are driver fatigue, substance impairment (e.g. alcohol, drugs, medication) and speeding. However, there are road related contributing factors which may add to the likelihood of a vehicle leaving the road on a curve and crashing, as listed in the **Related safety deficiencies** section.

When this type of crash is identified as a significant trend, the site and detailed crash information must be investigated (e.g. time-of-day, day of the week, weather, light conditions, age of the drivers, etc.), to determine which factors are the main contributors to the safety problem. Only then can appropriate treatments to remove or reduce the influence of these factors be determined.

Treatment types

Suitable engineering countermeasures include:

- Advisory speed signs $
- Chevron alignment markers (CAMs) $
- Curve warning signs $
- Linemarking improvements $
- Raised reflective pavement markers (RRPMs) $
- Reinstate shoulder $
- Separation lines $
- Sight distance improvements – road sections $
- Turn bans $
- Warning signs $
- Clear zone widening $$
- Crash cushion/impact attenuator $$
- Edge drop removal $$
- Edge lines $$
- Remove vegetation $$
- Safety barriers $$
- Skid resistance improvements $$
- Pavement drainage improvements $$$
- Traffic lane widening $$$
- Vehicle activated signs $$$
- Road realignment $$$$$
- Shoulder widening and/or sealing $$$$$

Pictures

OFF CARRIAGEWAY RIGHT BEND

Image 1 of 5

Related safety deficiencies

- Curve – concealed hazards
- Curve – crest combination
- Curve – inadequate delineation
- Curve – lack of advance warning
- Curve – lack of superelevation
- Curve – sharp
- Delineation – inadequate
- Drainage – inadequate
- Grade – too steep
- Linemarking – dividing line inadequate
- Pavement – poor skid resistance
- Pavement – unsealed issues
- Road lighting – inadequate
- Roadside hazard – drainage
- Roadside hazards – poles, piers, trees, etc.
- Roadside hazards – steep or non-driveable roadside
- Roadside hazards – unprotected bridge end posts
- Roundabout – inadequate design
- Shoulders – inappropriate standard/condition
- Sight distance – restricted
- Traffic lanes – inadequate, unclear, too narrow
- Unsignalised intersection – Y junction issue
- Vegetation – interference with driving task

Figure 2 – crash type screen

By selecting an individual treatment type, the user may learn more about its features, benefits and implementation issues. A 'ball park' cost figure is provided along with an expected treatment life (these will vary from jurisdiction to jurisdiction, and depend on the size and quality of the individual treatments).

Figure 3 shows a typical layout of a typical treatment type.

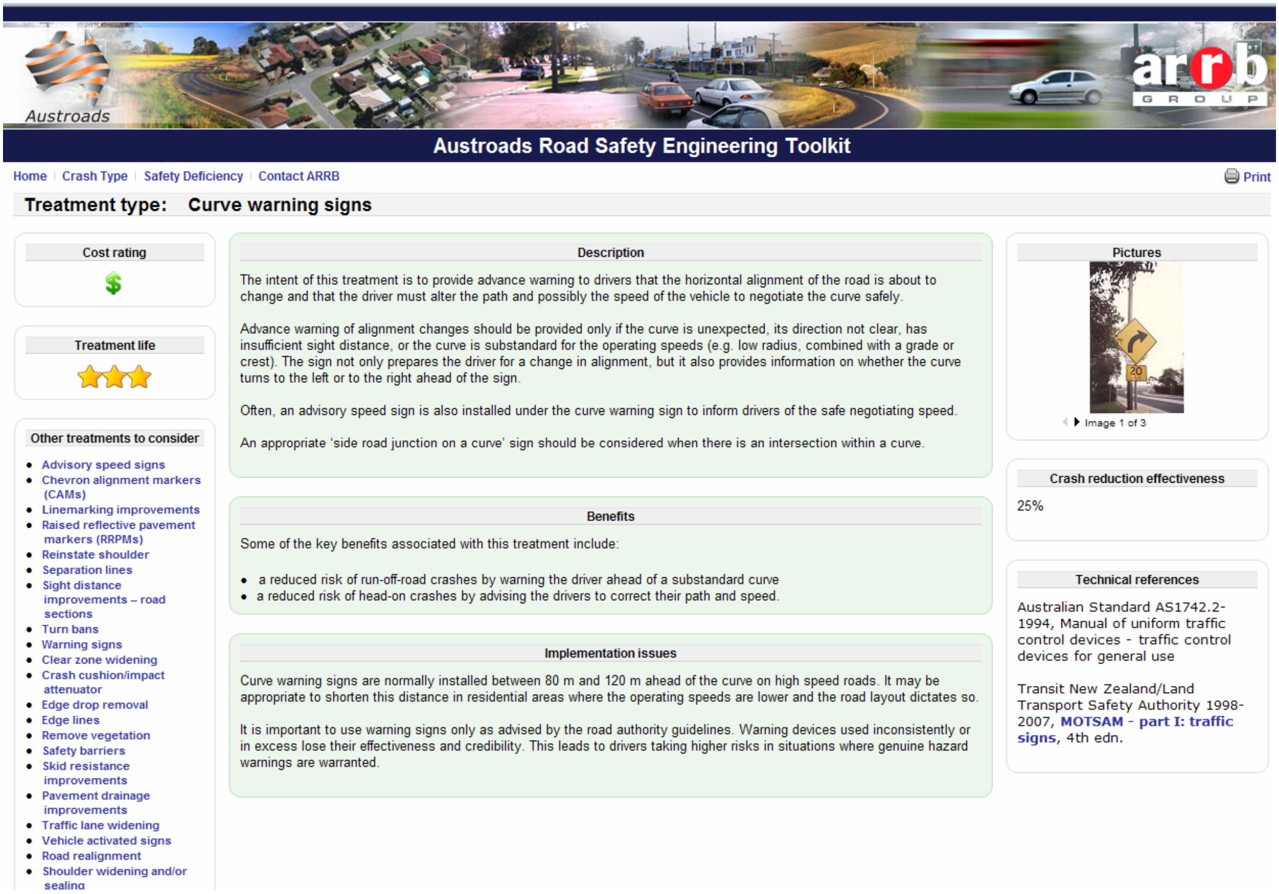


Figure 3 – treatment type screen

The individual treatment types provide the expected casualty crash reduction factors. These are based on the recent overview of published road safety literature on crash countermeasures. This review was carried out under the Austroads Road Safety Engineering Risk Assessment research program between 2004 and 2007.

The Toolkit provides photographic examples of individual treatments from around Australia, New Zealand and some overseas locations.

For most treatments, there are technical references provided, some with links to internet sites containing the documents. This section is being in expanded in 2007-08 to cover all jurisdictions.

In total, the Toolkit contains 62 treatment types.

Safety deficiency approach is an alternative path for analysing on-site road safety problems. This approach focuses on identified road features, which when missing or deficient are known to contribute to increased crash risk. These are grouped by themes, e.g. curves, traffic signals, linemarking, pedestrians, signalised intersections, cyclists, etc.

For each selected safety deficiency type there is a short physical description of the deficiency and a discussion on how it impacts road user behaviour resulting in increased risk. Some discussion on factors contributing to the crash severity is also provided. The user may explore the shortlist of relevant treatment types, in order of ascending costs, which may help to remedy the deficiency and thus to reduce the crash risk.

Each safety deficiency has a number of photographic examples to assist the practitioners with its on-site identification. At any time, the user may move 'sideways' by selecting and exploring a crash type related to the given safety deficiency. Figure 4 shows a typical safety deficiency screen layout.

Safety deficiency: Curve – sharp

Description

Horizontal road curves should be designed to suit the expected operating speeds on the adjoining road sections. When a road curve is constructed with a smaller radius than recommended for the operating speed (e.g. 80 km/h curve on a road with a 100 km/h operating speed), it may be expected to pose additional risk to drivers, and is considered substandard.

The design parameters for horizontal curves are provided in the Austroads road design guides and jurisdictions' design manuals.

A sharp curve will require the driver to slow down considerably before entering it in order to navigate the turn. In some cases, when the sharpness of the curvature is not clear to the approaching driver (e.g. inadequate warning or delineation), the driver is forced to brake within the curve and/or take a larger radius by encroaching into the opposing lane. Such sudden corrective actions increase the risk of loss of control, skidding and a crash into the roadside, or an oncoming vehicle. A sharp curve also increases a vehicle's swept path, so wide or long vehicles on sharp curves are likely to increase the crash likelihood for other road users by shoulder or lane encroachment.

Sharp curves in a hilly terrain will often also have restricted sight distances which will impede the driver's ability to read the road features ahead and beyond the curve (e.g. additional sharp curve or crest).

The number of vehicles travelling through the deficient curve each day will have a direct effect on the number of crashes. Unexpected sharp curves on high speed roads are more likely to experience crashes, and typically of a higher severity, than similar curves on low speed roads.

The roadside profile (e.g. level vs. drop-off) and the presence of unshielded roadside hazards also have a big influence on the severity of crashes.

In some cases a sharp curve may be combined with other deficiencies, such as poor delineation, inadequate lane width, reverse or inadequate superelevation or poor drainage.

Pictures

Image 1 of 4

Related crash types

- Head-on
- Motorcyclist crashes
- Run-off-road on curve

Treatment types

Suitable engineering countermeasures include:

Advisory speed signs	$
Chevron alignment markers (CAMs)	$
Curve warning signs	$
Linemarking improvements	$
Raised reflective pavement markers (RRPMs)	$
Reinstate shoulder	$
Restrict access points	$
Sight distance improvements – road sections	$
Speed limit change	$
Barrier lines	$ $
Clear zone widening	$ $
Edge drop removal	$ $
Edge lines	$ $
Remove vegetation	$ $
Safety barriers	$ $
Skid resistance improvements	$ $
Street lighting	$ $ $
Traffic lane widening	$ $ $
Vehicle activated signs	$ $ $
Road realignment	$ $ $ $ $
Shoulder widening and/or sealing	$ $ $ $ $
Superelevation improvement	$ $ $ $ $

Alternative non-engineering measures

Speed limit enforcement and media campaigns, blood alcohol/drugs content testing, fatigue management campaigns.

Figure 4 – safety deficiency screen

In total, there are 45 safety deficiencies presented in the Toolkit.

Toolkit Uses

The Toolkit has been developed with a broad range of road industry practitioners in mind, but is not intended to replace the current Austroads road safety publications as a source of in-depth policy and technical information. The focus on ease of use makes the Toolkit of added benefit to practitioners for whom road safety is not the main area of expertise. Those practitioners with extensive knowledge and understanding of road safety issues will benefit from the references section contained within each treatment type.

One of the key uses of the Toolkit is in black spot treatment selection. The crash type path allows navigation through various treatment types which may be applicable to treat the dominant crash problem at an intersection or a road section.

The safety deficiency path is of use in the Road Safety Audit process, where auditors can learn about information relating to the road safety issues identified at the audited project or site. Other uses of this approach include:

- network level risk assessments (e.g. NetRISK, RSRM)
- road user feedback driven investigations
- road design

where practitioners may base decisions regarding individual road features on the information provided in the Toolkit.

Further Development

In 2007-08 ARRB continues to develop the Toolkit to increase its relevance to a broader range of road practitioners. It is intended to expand its technical, research and standards references, provide practical case studies, and to add new treatment types and photographs.

A number of user interface feature improvements are being implemented, such as:

- more emphasis on road user safety driven analysis (the third approach, parallel with crash type and safety deficiency)
- new section on road safety problem diagnosis and crash site analysis
- new mechanism for a two-way exchange of best-practice case studies in road safety engineering.

Further development will also bring the Toolkit into line with the Austroads Guide to Road Safety, Part 8 – Treatment of Crash Locations scheduled for completion in 2008.