A6 Accident costs

A6.1 Introduction

Introduction

This appendix gives guidance on calculating accident cost savings for the do minimum and project options.

For the purposes of this manual, an accident is an event involving one or more road vehicles that results in personal physical injury and/or damage to property.

In this appendix

This appendix contains the following topics:

	Topic	**Page**
A6.1	Introduction	A6-1
A6.2	Choosing to undertake an accident analysis	A6-4
A6.3	Applying the analysis methods	A6-11
A6.4	Accident trends	A6-17
A6.5	Typical injury accident rates and prediction models	A6-20
A6.6	Typical accident reduction factors	A6-48
A6.7	Adjusting accident costs to reflect mean speeds	A6-52
A6.8	Worked example of accident procedures	A6-53
A6.9	Tables	A6-56
A6.10	References	A6-64

A6.1 Introduction, continued

When to do an accident analysis

Not all project evaluations require an accident analysis. An accident analysis may be appropriate where one or more of the following is true:

(a) at intersections or sites less than 1 km in length, within the last 5 years there have been:

- 5 or more injury accidents; and/or
- 2 or more serious or fatal accidents;

(b) at sites longer than 1 km in length, within the last 5 years there have been:

- 3 or more injury accidents per km; and/or
- 1 or more serious or fatal accident per km;

(c) there is some commonality amongst the accidents that have occurred;

(d) a recognised accident investigation specialist considers that the site has significant safety deficiencies (eg, high accident risk sites);

(e) there is a high level of public concern;

(f) there will be a fundamental change in the site where the types of accidents or level of accident severity will change significantly, such as:

- improvements will significantly alter the traffic speed or the distribution of traffic within a network; or
- new links or intersections are being added to a road network.

Low volume roads

For sites with AADT less than 1,500 vehicles per day (vpd) that do not meet requirement (a) or (b) above, the last ten year history can be used. The ten year history must be divided by two to obtain an equivalent five year history for analysis.

Remote and near rural roads

Remote rural roads are sites carrying less than 1,000 vpd and are more than 20 km away from a town with a population of 3,000 or more. Other rural sites are near rural.

Accident analysis methods

There are three accident analysis methods available:

- method A: Accident by accident analysis
- method B: Accident rate analysis
- method C: Weighted accident procedure.

Appendix A6.2 gives guidance as when to undertake an analysis and what method(s) to use.

A6.1 Introduction, continued

General process

The general process for an accident analysis is as follows:

(a) Select the appropriate analysis procedure(s) using appendix A6.2 and, depending on the method(s) selected:

- determine the historic accident performance by analysis of accident records, typically over the last 5 years;
- select the accident prediction models or exposure-based accident prediction equations for the do minimum and project options from appendix A6.5.

(b) Assess the annual accident performance and corresponding accident costs for the do minimum and the project options. Adjust for general trends in accident occurrence.

(c) Calculate the annual accident cost savings. These are the future annual accident costs of the do minimum less the future annual accident costs of the project options.

A6.2 Choosing to undertake an accident analysis

Introduction

Several factors affect the decision of whether or not to undertake an accident analysis and the choice of method used for that analysis including:

- the nature of the site (eg, AADT, length)
- the availability of a reliable accident history for at least five years
- the availability of suitable accident prediction models or exposure-based accident prediction equations
- if the project options will result in a fundamental change in the site

The following sections discuss these factors and their effect on the accident analysis.

Site

A site is the specific road infrastructure for which an evaluation is carried out. A site can be a bridge, intersection, mid-block, curve, S-bend, etc, or any combination of these, eg, a mid-block and an intersection. In the case of combinations, a site may have to be broken into parts for the purpose of evaluation.

Accident history

For the purpose of accident analysis, generally a minimum of the past five years (sixty months) of reported accident history is used. This reduces the error caused by regression to the mean.

The principle of regression to the mean states that when an earlier measurement is either extremely high or extremely low, then the expected value of later measurements will be closer to the true mean than the observed value of the first.

The effect of regression to the mean can be reduced by using a longer accident history when investigating accidents at a site, and by ensuring that there is a commonality amongst accidents at the site.

Completeness of accident history data

The latest data available in the Crash Analysis System (CAS) should be used for accident analysis. As there is typically a lag between the time when an accident occurs and when it is entered into CAS, care should be taken to ensure that the data being used is complete.

When establishing the accident history, it is considered good practice to check all the Traffic Crash Reports (TCR) along the length of the site and up to one kilometre either side. Where possible, the location of serious and fatal accidents should be discussed with the local Police to confirm the location, particularly along roads where it is suspected that accidents may have incorrect locations noted in the TCR. At sites with low accident occurrence, the impact of an incorrectly coded accident in the TCR, particularly a serious or fatal accident, can have a major impact on accident benefits (both positive and negative).

A6.2 Choosing to undertake an accident analysis, continued

Local accident data

Transit NZ and local authorities have set up systems that involve the collection of local contact accident data (also called 'contractor reported' or 'unreported to Police' accidents) from contractors, local residents and network management personnel. The quality of this data varies and caution should be taken when using it in accident analysis.

Local contact accident data can be used in an accident-by-accident analysis (Method A) where the data is supported by sufficient evidence to be audited and a reasoned justification provided as to why it should be used to supplement information from CAS. Evidence might include a second independent report of the accident, confirmation of accidents by the local Police or by local network contractors or consultants.

If local contact accident information is used for an analysis then under-reporting factors **must not** be included in the calculations of injury or non-injury accident costs.

Site characteristics

There are four site characteristics which have an impact on the time-span of accident history required and the method used for analysis:

- the traffic volume through the site
- whether or not there has been a major change at the site
- whether or not it is a new site (eg, new road or intersection)
- when there is no accident history

The table below illustrates the adjustment to the accident history requirements or the choice of accident analysis methods resulting from these characteristics.

If…	Then…
The site has an AADT equal to or greater than 1,500 vpd.	Use the latest 5-year accident history for the site being investigated.
The site has an AADT less than 1,500 vpd.	Use the latest 10-year accident history in addition to the latest 5-years to ascertain whether the site under consideration has an accident problem not revealed by the latest 5-years of data. Divide the 10-year accident numbers by two to obtain a equivalent 5 year accident history.

A6.2 Choosing to undertake an accident analysis, continued

Site characteristics, continued

If…	Then…
A major change has occurred at the site (prior to project implementation) that could be expected to have changed the incidence of accidents.	Use the accident history for the period since the change (minimum of 3 years), or adjust the record for the period prior to the change by removing those accidents remedied by the change.
The site is new (eg, a new road or intersection).	Use Method B.
There is no obvious accident history at the site.	Depending on the reasons for this, accident analysis may not be required. Contact Land Transport NZ.

Minimum number of accidents required for Method A

The use of Method A for accident analysis requires that a minimum number of accidents have occurred at the site, depending on the length of the site as follows:

at intersections or sites less than 1 kilometre in length, within the last 5 years there have been:

- 5 or more injury accidents; and/or
- 2 or more serious or fatal accidents;

at sites longer than 1 kilometre in length, within the last 5 years there have been:

- 3 or more injury accidents per kilometre; and/or
- 1 or more serious or fatal accident per kilometre;

Generally, there should be some commonality amongst the accidents that have occurred.

Where a site does not meet these minimal requirements, then Method C (weighted accident procedure) may be used.

Fundamental change in a site

A project option results in a fundamental change in a site when the types of accident or the level of accident severity is expected to change significantly. The following list gives examples of site changes that would result in a fundamental change:

- a completely new site is being provided (such as a new road or intersection)
- realignment of a road (other than an isolated curve)
- removal or significant modification of road elements (eg, grade separation of a railway crossing and conversion of a single lane bridge to a two-lane bridge)
- change in intersection form of control
- flush median
- adding lanes, including passing lanes.

A6.2 Choosing to undertake an accident analysis, continued

Fundamental change in a site, continued

Project options that are not normally regarded as resulting in fundamental changes include:

- upgrade of a single or s-bend to a higher design speed curve or s-bend
- shoulder widening on rural roads (in the absence of road realignment)
- signage and delineation improvements, including lighting
- traffic volume changes (in the absence of other improvements)
- road resurfacing and shape corrections
- minor improvement works.

Method A (accident-by-accident) is normally applied to project options that do not result in a fundamental change in a site. When there is a fundamental change, Method B is generally used for analysis of the project option, while Method C or A can be used for the do minimum. In some cases, Method C or Method B may be used for both.

Where there is a fundamental change in a site but no accident prediction models or exposure-based accident prediction equations are available for the do minimum, Method A can be used for the do minimum while Method B is used for the project options, providing that models are available for the project options.

Area-wide changes in traffic networks

When considering projects of an area-wide nature, such as the evaluation of an urban traffic network, eg, for transport planning or traffic management studies, it is insufficient to calculate accident costs from changes in global totals of vehicle-kilometres of travel.

Where a new road link is being added to a network, or a network change will result in major redistributions of traffic, analysis is required of the incidence of accidents on the links to which the traffic is being diverted.

For a new link, use Method B accident prediction models or exposure-based accident prediction equations appropriate to its intended design, speed limit and intersections along it. On major links that experience significant changes in traffic volumes, accident prediction models are preferred (where available) over exposure-based accident prediction equations.

Availability of models and equations

In the absence of an adequate accident history for the site, Method B or C may be used, provided there is a suitable accident prediction model or exposure-based accident prediction equation available. A summary of the available models and equations is found in appendix A6.3 while appendix A6.5 provides the details about them.

Accident prediction models or exposure-based accident prediction equations other than those specified may be used if the robustness of these models or equations can be demonstrated to Land Transport NZ and a peer reviewer.

A6.2 Choosing to undertake an accident analysis, continued

Guidance

The procedure below gives step-by-step guidance as to when an accident analysis may be required and what method(s) should be applied.

Selecting the accident analysis method

Follow the steps below to determine the need for an accident analysis and the appropriate accident analysis method(s).

<table>
<tr><th>Step</th><th colspan="2">Action</th></tr>
<tr><td rowspan="4">1</td><td colspan="2">Choose the appropriate length of accident history period for the site as follows:</td></tr>
<tr><th>If the section has an AADT of</th><th>Then the accident history period should be at least …</th></tr>
<tr><td><1500 vehicles per day</td><td>10 years
(if the last five year history has insufficient accidents, use 10 year history divided by 2)</td></tr>
<tr><td>>1500 vehicles per day</td><td>5 years</td></tr>
<tr><td rowspan="4">2</td><td colspan="2">Accident history should in the first instance be obtained from the Crash Analysis System (CAS). Where necessary, verified local contact accident information can be used to supplement and update CAS. Refer to preceding sections for further description.
Determine whether or not the accident history is adequate as follows:</td></tr>
<tr><th>If the available accident history for the site is …</th><th>Then …</th></tr>
<tr><td>Too short / insufficient</td><td>Go to step 3.</td></tr>
<tr><td>Long enough / sufficient</td><td>Go to step 4.</td></tr>
<tr><td rowspan="5">3</td><td colspan="2">Where there was a significant change at the site at least three years earlier, a shorter period of accident history may be acceptable if factored up to a five year period as follows:</td></tr>
<tr><th>If there is</th><th>Then …</th></tr>
<tr><td>At least 3 years of available accident data</td><td>Factor the information to cover a 5 year period. Go to step 4.</td></tr>
<tr><td>Less than 3 years of available accident data</td><td>Go to step 8.</td></tr>
<tr><td colspan="2">Where a shorter time period has been factored for use in the accident analysis, a peer review of the analysis will be required before it is submitted with the project evaluation.</td></tr>
</table>

A6.2 Choosing to undertake an accident analysis, continued

Selecting the accident analysis method, continued

Step	Action
4	Determine whether or not there are the minimum number of accidents at the site as follows:

If the site is …	and the minimum number of accidents is …	Then …
An intersection or road section <1 km long	≥5 injury accidents or ≥2 serious and fatal accidents	Go to step 7.
An intersection or road section <1 km long	<5 injury accidents or <2 serious and fatal accidents	Go to step 5
A road section >1 km	≥3 injury accidents/km or ≥1 serious and fatal accidents/km	Go to step 7.
A road section >1 km	<3 injury accidents/km or <1 serious and fatal accidents/km	Go to step 5

Step	Action
5	Consider whether or not an accident analysis is feasible using accident prediction models or exposure-based accident prediction equations (as given in appendix A6.5) as follows:

Is there an accident prediction model or exposure-based accident prediction equation available for the do minimum and project option(s)?	Then …
Yes	Go to step 6
No	Go to step 9

Step	Action
6	Where there is not a sufficient accident history and models or exposure equations are available, choose the accident analysis method as follows: Fundamental change is defined earlier in appendix A6.2.

Will the project result in a fundamental change at the site?	Where there is insufficient accident history, conduct an accident analysis using
Yes	Method C for do minimum Method B for project option
No	Method C for do minimum and project option

A6.2 Choosing to undertake an accident analysis, continued

Selecting the accident analysis method, continued

<table>
<tr><td rowspan="4">7</td><td colspan="2">Where there is a well-established accident history, choose the accident analysis method as follows:

Fundamental change is defined earlier in appendix A6.2.</td></tr>
<tr><td>Will the project result in a fundamental change at the site?</td><td>Where there is good accident history information, conduct an accident analysis using</td></tr>
<tr><td>Yes</td><td>Method A for do minimum

Method B for project option</td></tr>
<tr><td>No</td><td>Method A for do minimum and project option</td></tr>
<tr><td>8</td><td colspan="2">Where there is no or unreliable accident, use Method B for do minimum and project option where accident prediction models or exposure-based accident prediction equations are available.</td></tr>
<tr><td rowspan="4">9</td><td colspan="2">Where a site fails to meet any of the preceding criteria for undertaking an accident analysis, it may be possible to undertake an accident analysis if the following criterion is met:</td></tr>
<tr><td>Is the site a rural re-alignment and does a recognised accident investigation specialist consider the site to have significant safety deficiencies?</td><td></td></tr>
<tr><td>Yes</td><td>Conduct a peer reviewed accident by accident analysis (Method A)</td></tr>
<tr><td>No</td><td>Go to step 10</td></tr>
<tr><td>10</td><td colspan="2">Where there is insufficient accident history and no accident prediction models or exposure-based accident prediction equations available, contact Land Transport NZ.</td></tr>
</table>

A6.3 Applying the analysis methods

Introduction	This section describes the general process for how to determine future annual accident numbers and costs for the do minimum and project options using the three analysis methods: • Method A: Accident-by-accident analysis • Method B: Accident rate analysis • Method C: Weighted accident procedure. Worked examples of the Methods B and C are provided in appendix A6.8.
Intersection accidents	Accidents occurring within the area of priority controlled intersections, roundabouts and traffic signals on the primary road network, and up to 50 m from the intersection.
Mid-block accidents	Accidents occurring on a road section excluding accidents at major intersections. Accidents at minor intersection are sometimes included.
Categorisation by speed limit	Accidents are categorised according to the speed limit areas in which they occur: • 50 km/h speed limit areas (including 30 km/h and 60 km/h areas) • 70 km/h speed limit areas (including limited speed zones) • 100 km/h speed limit areas (including 80 km/h and above areas).
Types of accident rate	An accident rate is the average number of injury accidents per year, measured over a period of time (normally five calendar years). **Site-specific accident rate (A_S)** is the accident rate for a specific site based on reported injury accidents on the record of TCRs prepared by the Police and compiled by Land Transport NZ. These are available from the Crash Analysis System (CAS). **Typical accident rate (A_T)** is the accident rate for a typical or generic site, eg, a bridge, with characteristics similar to the site being evaluated. Typical accident rates are determined using either an accident prediction model or exposure-based accident prediction equation, depending on the type of site, or part of a site, being evaluated. **Weighted accident rate (A_W)** The accident rate produced when using the weighted accident procedure.

A6.3 Applying the analysis methods, continued

Method A: accident-by-accident analysis

Accident-by-accident analysis is based on the accident history of the site and is dependent on the number of reported accidents, as set out in appendices A6.1 and A6.2. The analysis uses the individual accident severity categories (fatal, serious, minor, non-injury) and these can be further disaggregated by movement category and/or type of vehicle involved.

In the first stage of the analysis, using the worksheets in chapter 5, the do minimum total estimated number of accidents per annum is calculated. Costs are assigned using the accident costs from tables A6.21(a) to (d) for 50 km/h speed limit areas and from tables A6.21(e) to (h) for 100 km/h speed limit areas.

The number of accidents predicted for a project option is determined from an expected reduction in the do minimum accident numbers, based on the guidance provided in Appendix A6.6. The forecast percentage accident reductions for the project option can be applied either globally or varied for each accident type and severity (eg, for fatal, serious, minor and non-injury accidents). Costs are taken from tables A6.21(a) to (h) as appropriate to the site. Where the mean speed of traffic for the do minimum and/or options differs from that provided in table A6.21, an adjustment should be made to the costs using the formula found in appendix A6.7.

Severity

In Method A, accidents are categorised by the most severe injury sustained. The four severity categories are:

Fatal	When death ensues within 30 days of the accident.
Serious	Injuries requiring medical attention or admission to hospital, including fractures, concussion and severe cuts.
Minor	Injuries other than serious, which require first aid or cause discomfort or pain, including bruising and sprains.
Non-injury	When no injuries occur, sometimes referred to as 'property damage only' (PDO) accidents.

The accident reports from police officers recorded in CAS are to be used to classify accident severity in preference to hospital records.

Changes in accident severity

Project options, such as crash barriers, can in some cases reduce the accident severity at a site. Use Method A, rather than Method B or C, when the majority of accident benefits are obtained from a reduction in accident severity.

A6.3 Applying the analysis methods, continued

Vehicle involvement

In assigning costs to accidents using Method A, accidents are classified by 'vehicle involvement' according to the highest ranked 'vehicle' involved in an accident. The ranking from highest vehicle to lowest vehicle is:

- pedestrian
- push cycle (bicycle)
- motorcycle including moped
- bus
- truck
- cars, light commercial vehicles and any other.

For example, an accident involving a truck and a push cycle is categorised as a 'push cycle accident'.

Adjustment for under-reporting

Only a proportion of non-fatal accidents that occur are recorded on TCR and in CAS. This is referred to as under-reporting. It is generally assumed that all fatal accidents are reported.

To counteract the effect of underreporting when using Method A, factors are applied to reported accident numbers (TCR numbers) to estimate the total number of accidents that actually occur. Table A6.20(a) provides factors for converting from reported injury accidents to total injury accidents, while table A6.20(b) provides factors for converting from reported non-injury accidents to total non-injury accidents.

If local contact accident information has been used, then under-reporting factors must not be included in the calculations of injury or non-injury accident costs.

Change in traffic volume

If there is a change in traffic volume for the project option compared with the do minimum, then the accident numbers must be scaled in proportion to this change.

Method B: Accident rate analysis

Accident rate analysis involves determining a typical accident rate per annum as the basis for calculating the accident cost savings for a project. Typical accident rates have been calculated using either an accident prediction model or an exposure-based accident prediction equation from appendix A6.5, which have been derived using information from similar types of site elsewhere.

In some cases, the models used for the do minimum and the project option already account for the proposed improvement/treatment of the site (eg, an intersection treatment to change from priority or a roundabout to signalised; the construction of a two-lane rural bridge to replace a single lane bridge). In others, it may be necessary to apply an accident reduction factor from appendix A6.6 to the project option model or equation to take account of the site treatment/improvement (eg, various mid-block pedestrian treatments; construction of a cycle lane).

A6.3 Applying the analysis methods, continued

Method B: Accident rate analysis, continued

In accident rate analysis, it is not possible to differentiate accidents other than by speed limit category, therefore the accident costs are taken from table A6.22, and are for 'all vehicles and all movements combined'. Where the mean speed of traffic for the do minimum and/or options differs from that provided in table A6.22, an adjustment should be made to the costs using the formula found in appendix A6.7.

Only reported injury accidents are considered when using accident rate analysis because of the inconsistency in non-injury reporting rates from district to district.

Method C: Weighted accident procedure

The weighted accident procedure uses both historical accident data relating to a particular site, and the typical accident rate for the site, as calculated from the appropriate accident prediction model or exposure-based accident prediction equation (from appendix A6.5).

The historical data is converted into a site-specific accident rate by dividing the reported accidents by the number of years of data. The site-specific accident rate is then combined with the typical accident rate, resulting in a weighted accident rate for the do minimum and project option(s).

Accident cost savings for the do minimum and option(s) are calculated using the costs provided in table A6.22. Where the mean speed of traffic for the do minimum and options differs from that provided in table A6.22, an adjustment should be made to the costs using the formula found in appendix A6.7.

The weighted accident procedure also allows analysis of sites with no accident history, provided that the site has been in existence for more than 3 years with no major changes.

Use of site specific accident rates

For existing links, use site-specific accident rates calculated from the accidents that have occurred on the links.

Where there is low accident occurrence due to short link lengths or low traffic volumes, site-specific accident rates can be unrealistic. In this case, accident prediction models, exposure-based accident prediction equations or site-specific accident rates from adjoining links should be used to determine future accident numbers. Intersections and other sites can be similarly analysed if necessary.

Weighted accident rate for the do minimum

The do minimum weighted accident rate is calculated using the following equation:

$$A_{W,dm} = w \times A_T + (1 - w) \times A_S$$

where:

$A_{W,dm}$ is the do minimum weighted accident rate

A_T is the typical accident rates calculated from the appropriate accident prediction model or exposure-based accident prediction equation (from appendix A6.5) for the do minimum

A_S is the site-specific accident rate (from historical accident data)

w is the weighting factor.

A6.3 Applying the analysis methods, continued

Weighting factor (w)

When **w** = 1, the method simplifies to an accident prediction model or equation (Method B).

When **w** = 0, the method simplifies to an accident-by-accident analysis (Method A).

w is calculated using the following equation if **k** is specified:

$$\mathbf{w} = \frac{\alpha_X^2 \times k}{\alpha_X^2 \times k + \alpha_M^2 \times A_T}$$

If **k** is not specified then the equation for **w** is:

$$\mathbf{w} = \frac{\alpha_X^2}{\alpha_X^2 + \alpha_M^2 \times A_T}$$

Where: **k** is a dispersion parameter (defined below), and

α_X and α_M are reliability factors (defined below).

Dispersion parameter (k)

k is a dispersion parameter of the negative binomial distribution, which is the probability distribution assumed for the accident data. **k** values for different sites are in appendix A6.5.

Generally the higher the value of k the higher the accuracy of an accident prediction model (and vice versa). The accuracy is, however, also relative to the typical accident rate at a site, ie, a low **k** value may be acceptable at a site with a low typical accident rate but unacceptable at a site with a high typical accident rate.

For a mid-block, the typical accident rate (A_T) must be divided by the length of the mid-block because the mid-block **k** values provided in appendix A6.5 are on a per kilometre basis.

Reliability factors (α_X, α_M)

An assessment of the reliability of both the site-specific accident rate and the typical accident rate is required for Method C. The reliability factor for the site-specific accident rate is α_X and the reliability factor for the typical accident rate is α_M.

The main factor influencing the reliability of the site-specific accident rate is whether accidents are correctly coded at the site. Accidents may be missing from the site or may be incorrectly coded within the site. For example, an accident may be incorrectly coded within a series of back-to-back curves, where it is not always easy to accurately locate the exact curve the accident occurred on.

When the historical accident data is reliable, α_X should equal 1.0 (this is the default setting). When it is unreliable, α_X should be between 1.0 and 2.0, with 2.0 being very unreliable data.

A6.3 Applying the analysis methods, continued

Reliability factors (α_X, α_M), continued

The reliability of the typical accident rate information presented in appendix A6.5 is an issue when an accident prediction model or exposure-based accident prediction equation is used for:

- A different type of site, or part of a site, than the model or equation was derived for. For example, a 4-arm roundabout model might be used for a 3-arm roundabout (the prediction would then be approximately 75 percent of that given by the model)
- A 'non-standard' intersection, mid-block or other site or part of a site. An example of a 'non-standard' intersection would be one with many traffic signal phases (say 5 or 6) or greater than four approach lanes.

In both situations α_M should be increased above 1.0 (the default value). A value of 2.0 would represent poor reliability.

Weighted accident rate for project option

Method C can only be used for the project option when it does not bring about a fundamental change in a site. In this case, the site-specific historic accident data is still relevant for the project option. The project option weighted accident rate is calculated by increasing or decreasing the typical accident rate of the project option by the same proportion used to adjust the do minimum typical accident rate to the do minimum weighted accident rate.

$A_{W,opt} = A_{T,opt} \times A_{W,dm} / A_{T,dm}$

where: $A_{W,opt}$ is the weighted accident rate for the option

$A_{W,dm}$ is the weighted accident rate for the do minimum

$A_{T,opt}$ is the typical accident rate calculated from accident prediction models or exposure-based accident prediction equations for the option. Note that it may be necessary to apply a reduction factor from Appendix A6.6 if the prediction model or equation does not already take the treatment / improvement into account.

$A_{T,dm}$ is the typical accident rate calculated from accident prediction models or exposure-based accident prediction equations for the do minimum.

A6.4 Accident trends

Introduction

This section provides guidance on the adjustment of accident numbers for general accident trends.

General accident trends

Since 1985, there has been a downward trend in reported traffic accidents. At the same time that accident numbers have decreased, traffic volumes have increased, indicating that accidents rates have decreased more than accident numbers.

The combination of these two factors means that typical accident rates established from past research and site specific accident numbers need to be adjusted in order to give a realistic estimate of the likely accident situation at the project site in the future.

The adjustment to accident numbers is a two stage procedure, with the first adjustment being to modify the accident numbers at time zero and the second adjustment being to modify the growth rate used for discounting accident benefits to take account of the forecast continued trend after time zero.

There have been marked differences between the accident trends in 50 km/h areas compared with 70 km/h and above areas, and different factors are used to modify the accident numbers for the different posted speed limit areas.

Table A6.1(a) provides factors to convert historic average accident numbers to time zero for Method A. For Method B, an equation is provided to adjust the rate to time zero.

Table A6.1(b) provides factors to modify the predicted future traffic growth rate when discounting the accident cost savings.

A6.4 Accident trends, continued

Adjustment to time zero

Accident numbers and rates for project evaluation are to be determined for time zero. This requires adjusting the observed or predicted number of accidents assessed at the mid-point of the analysis period to time zero. The procedure differs if using accident history (accident-by-accident analysis) or accident prediction models or rates (accident rate analysis).

Method A adjustment

This procedure should be followed if using accident-by-accident analysis. From table A6.1(a), select the appropriate adjustment factor for the site based on its traffic growth rate and posted speed limit. For example, for a project where the posted speed limit is 50 km/h and the traffic growth rate is 2 percent at time zero, the accident numbers will be factored by 0.90 to adjust the accident numbers to time zero.

Method B adjustment

This procedure should be followed if using accident rate analysis. As the prediction models and equations in appendix A6.5 use historical accident data, the predicted number of accidents needs to be adjusted for accident trends.

$A = A_T \times (1 + f_t (y_z - 2006))$

where:

A is the accident rate adjusted for accident trends

A_T is the typical rate found from models or rates

f_t is the factor for adjusting the typical rate

- -0.03 for sites with speed limits 60km/h and below
- -0.01 for sites with speed limits 70 km/h and above

y_z is year zero of the analysis period

Table A6.1(a) Accident trend adjustment factors

Speed limit	Traffic growth rate							
	0%	**1%**	**2%**	**3%**	**4%**	**5%**	**6%**	**7%**
50 and 60 km/h	0.83	0.86	0.90	0.93	0.96	0.99	1.03	1.06
70 km/h and above	0.95	0.98	1.02	1.06	1.10	1.14	1.17	1.21

A6.4 Accident trends, continued

Adjusting traffic growth rate for discounting

When discounting the accident cost savings from time zero forwards the predicted growth rate is adjusted to reflect the predicted continued trend in accidents. Table A6.1(b) provides the adjustments to use for the different speed limit areas.

Using the factors in table A6.1(b) it is possible for the accident growth rate used for discounting to be negative if the predicted traffic growth rate at the site is less than 3 percent in 50 km/h areas or 1 percent in 70 km/h and above areas. For example, if the site is in a 50 km/h posted speed area and the traffic growth rate for the site is 1.5 percent then the growth rate to use for discounting accident costs is 1.5 – 3 = –1.5, ie, –1.5 percent is entered in the discounting equation.

Table A6.1(b) Growth rate adjustment factors

	Posted speed limit	
	50 and 60 km/h	**70 km/h and above**
Modification to traffic growth rate	–3%	–1%

A6.5 Typical injury accident rates and prediction models

Introduction

The typical accident rates and prediction models of reported injury accidents presented in this section are the result of studies carried out for Transit NZ and Land Transport NZ. Accident prediction models and exposure-based accident prediction equations differ in how they relate accidents to traffic volumes.

The exposure-based accident prediction equations in this section assume that the number of accidents at a site is directly proportional to traffic volume. That is, if the traffic volume doubles then the number of accidents will also double (if everything else remains the same).

However, for the accident prediction models the number of accidents per vehicle varies depending on the traffic volume. Therefore a doubling in traffic volume will not result in an accident rate that is double – in such cases the predicted accident rate can be significantly different from double the number of accidents.

Definition of exposure

Exposure to the risk of having an accident is defined as follows:

(a) For mid-blocks, exposure is the number of vehicle-kilometres of travel on the mid-block, measured in hundred million vehicle-kilometres per year, ie

$$\text{Exposure} = \frac{L \times AADT \times 365}{10^8}$$

where L is the section length in kilometres, and AADT is the annual average daily traffic.

(b) For sites, or parts of sites, other than mid-blocks, exposure is the number of vehicles travelling through, measured in hundred million vehicles per year, ie

$$\text{Exposure} = \frac{AADT \times 365}{10^8}$$

Types of terrain

In rural areas, the values for model co-efficients are based on different terrain types, defined as follows:

Terrain type	Definition
Level	Level or gently rolling country, with gradients generally from flat up to 3 percent, which offers few obstacles to an unrestricted horizontal and vertical alignment.
Rolling	Rolling, hilly, or foothill country with moderate grades generally from 3 percent to 6 percent in the main, but where occasional steep slopes may be encountered.
Mountainous	Rugged, hilly, and mountainous country (and river gorges) often involving long, steep grades over 6 percent, and considerable proportions of the road with limited sight distance.

Definition of movement category

There are movement categories which are groupings of the two letter movement codes used in CAS to categorise accidents. Figure A6.1 shows the CAS movement codes.

A6.5 Typical injury accident rates and prediction models, continued

Figure A6.1 CAS movement codes (version 2.4 February 2005)

	TYPE	A	B	C	D	E	F	G	O
A	OVERTAKING AND LANE CHANGE	PULLING OUT OR CHANGING LANE TO RIGHT	HEAD ON	CUTTING IN OR CHANGING LANE TO LEFT	LOST CONTROL (OVERTAKING VEHICLE)	SIDE ROAD	LOST CONTROL (OVERTAKEN VEHICLE)	WEAVING IN HEAVY TRAFFIC	OTHER
B	HEAD ON	ON STRAIGHT	CUTTING CORNER	SWINGING WIDE	* BOTH OR UNKNOWN	LOST CONTROL ON STRAIGHT	* LOST CONTROL ON CURVE		OTHER
C	LOST CONTROL OR OFF ROAD (STRAIGHT ROADS)	OUT OF CONTROL ON ROADWAY	OFF ROADWAY TO LEFT	OFF ROADWAY TO RIGHT					OTHER
D	CORNERING	LOST CONTROL TURNING RIGHT	LOST CONTROL TURNING LEFT	MISSED INTERSECTION OR END OF ROAD					OTHER
E	COLLISION WITH OBSTRUCTION	PARKED VEHICLE	CRASH OR BROKEN DOWN	NON VEHICULAR OBSTRUCTIONS (INCLUDING ANIMALS)	WORKMANS VEHICLE	OPENING DOOR			OTHER
F	REAR END	SLOW VEHICLE	CROSS TRAFFIC	PEDESTRIAN	QUEUE	SIGNALS	OTHER		OTHER
G	TURNING VERSUS SAME DIRECTION	REAR OF LEFT TURNING VEHICLE	LEFT TURN SIDE SIDE SWIPE	STOPPED OR TURNING FROM LEFT SIDE	NEAR CENTRE LINE	OVERTAKING VEHICLE	* TWO TURNING		OTHER
H	CROSSING (NO TURNS)	RIGHT ANGLE (70° TO 110°)							OTHER
J	CROSSING (VEHICLE TURNING)	RIGHT TURN RIGHT SIDE	OBSOLETE	TWO TURNING					OTHER
K	MERGING	LEFT TURN IN	RIGHT TURN IN	TWO TURNING					OTHER
L	RIGHT TURN AGAINST	STOPPED WAITING TO TURN	MAKING TURN						OTHER
M	MANOEUVRING	PARKING OR LEAVING	"U" TURN	"U" TURN	DRIVEWAY MANOEUVRE	PARKING OPPOSITE	ENTERING OR LEAVING	REVERSING ALONG ROAD	OTHER
N	PEDESTRIANS CROSSING ROAD	LEFT SIDE	RIGHT SIDE	LEFT TURN LEFT SIDE	RIGHT TURN RIGHT SIDE	LEFT TURN RIGHT SIDE	RIGHT TURN LEFT SIDE	MANOEUVRING VEHICLE	OTHER
P	PEDESTRIANS OTHER	WALKING WITH TRAFFIC	WALKING FACING TRAFFIC	WALKING ON FOOTPATH	CHILD PLAYING (TRICYCLE)	ATTENDING TO VEHICLE	ENTERING OR LEAVING VEHICLE		OTHER
Q	MISCELLANEOUS	FELL WHILE BOARDING OR ALIGHTING	FELL FROM MOVING VEHICLE	TRAIN	PARKED VEHICLE RAN AWAY	EQUESTRIAN	FELL INSIDE VEHICLE	TRAILER OR LOAD	OTHER

* = Movement applies for left and right hand bends, curves or turns

A6.5 Typical injury accident rates and prediction models, continued

General and conflicting flow models

General models are suitable for most mid-block or intersection types indicated. Where a breakdown of accidents by accident type or road user type is required; or, in the case of intersections, where the proportion of turning vehicles is high compared to through vehicles, then **conflicting flow** models should be used.

Available models and equations

This section contains general and conflicting flow accident prediction models and exposure-based accident prediction equations for:

	General models	**Conflict models**
Intersections - ≤70 km/h	(1) Urban cross and T intersections, 50-70 km/h - Uncontrolled, priority, traffic signals (2) Urban roundabouts, 50-70 km/h	(3) Urban signalised cross roads (4) Urban roundabouts
Mid-blocks	(5) Urban mid-blocks, 50-70 km/h	(6) Urban mid-block – pedestrians and cyclist facilities
High speed intersections	(7) High speed cross and T intersections, ≥80 km/h – priority and traffic signals	(8) High speed roundabout (9) High speed priority crossroads (10) High speed priority T-junctions
Rural roads	(11) Rural two lane roads, ≥80 km/h (12) Rural two-lane roads: heavy vehicles (13) Motorways & 4-lane divided rural roads (15) Rural passing lanes accident reduction factor	(14) Rural isolated curves (≥80 km/h)
Rural bridges	(16) Single lane rural bridges, >80 km/h (17) Two lane rural bridges, >80 km/h	
Railway crossings	(18) Urban and rural railway crossings – half arm barriers; flashing lamps and bells, no control	

A6.5 Typical injury accident rates and prediction models, continued

Application of models and equations

All accident prediction models and exposure-based accident prediction equations calculate total injury and fatal accidents per year. The models and equations are valid within the flow ranges provided. Analysts should exercise caution when using the models and equations outside these ranges.

The accident prediction models and exposure-based accident prediction equations in this section have been developed for the most common types of site in each category. For example, traffic signal models were developed for two and three phase signals, and are therefore not as accurate for signals with four or more phases, or where there are a lot of phase changes during set periods of the day.

The more unusual a site is from the typical site type, the less appropriate the general models and equations will be for predicting the typical accident rate. In most cases where there is a feature of a site, such as the site's layout, that has a significant effect on the accident rate, the models and equations in this section are not likely to be appropriate.

Models and equations from other sources

Analysts are permitted to use accident prediction models and exposure-based accident prediction equations from other sources, as long as the robustness of these other sources can be demonstrated. These sources need to be referenced (eg, papers, research reports or unpublished material), along with information on sample size, modelling technique and goodness-of-fit statistics.

For intersection and mid-block accident prediction models, analysts are referred to the appropriate research report on accident prediction models. The accident prediction models in these reports are useful for determining the effects of varying traffic demands on particular movements at intersections, mode split and site specific features.

A6.5 Typical injury accident rates and prediction models, continued

(1)

General cross and T urban intersection 50-70 km/h

The 'general' model is suitable for most urban cross and T intersection types and uses two-way link volumes where the posted speed limit is 50-70 km/h. Where a breakdown by accident type and road user type is required, or where the proportion of turning vehicles is high compared to through vehicles, then the appropriate conflicting flow models should be used.

For urban intersections on the primary road network (excluding roundabouts), the typical accident rate (reported injury accidents per year) is calculated using:

$$A_T = b_0 \times Q_{major}^{b_1} \times Q_{minor/side}^{b_2}$$

where:

Q_{major} the highest two-way link volume (AADT) for cross-roads and the primary road volume for T-junctions

$Q_{minor/side}$ the lowest of the daily two-way link volumes (AADT) for cross-roads and the side road flow for T-junctions

b_0, b_1 and b_2 are given in table A6.2(a).

Table A6.2(b) shows the range of flows over which the accident prediction models should be applied. The k values are for use in the weighted accident procedure.

Caution

Caution should be exercised when using the prediction models for intersections where opposing approach flows (on Q_{major} or Q_{minor}) differ by more than 25 percent. In such cases, conflicting flow models should be used.

Table A6.2(a) Urban intersection injury accident prediction model parameters (2006)

Intersection type	b_0	b_1	b_2
Uncontrolled – T	2.53×10^{-3}	0.36	0.19
Priority – Cross	1.25×10^{-3}	0.21	0.51
Priority – T	5.65×10^{-5}	0.76	0.20
Traffic signals – Cross	3.25×10^{-3}	0.46	0.14
Traffic signals – T	1.52×10^{-1}	0.04	0.12

Table A6.2(b) Urban intersection injury accident flow ranges and k values

Intersection type	Range Q_{major} AADT	Range Q_{minor} AADT	k value
Uncontrolled – T	3,000 – 30,000	500 – 4,000	2.6
Priority – Cross	5,000 – 22,000	1,500 – 7,000	2.3
Priority – T	5,000 – 26,000	1,000 – 5,000	3.8
Traffic signals – Cross	10,000 – 32,000	5,000 – 16,000	4.8
Traffic signals – T	11,000 – 34,000	2,000 – 9,000	4.6

A6.5 Typical injury accident rates and prediction models, continued

(2)

General urban roundabouts, 50-70 km/h

Often roundabouts do not have the roads with the highest or lowest volumes on opposing arms, or if they have three arms these are seldom in a 'T'. Therefore, accidents are calculated for each arm of the roundabout, and the total obtained by adding these together. The typical accident rate (reported injury accidents per approach per year) is calculated using the model:

$A_T = b_0 \times Q_{approach}^{b_1}$

where:

$Q_{approach}$ the two-way link volume (AADT) on the approach being examined.

b_0, and b_1 are given in table A6.3(a).

This model can be applied for roundabouts with three, four or five approaches. Table A6.3(b) shows the range of flows over which the accident prediction model should be applied. The k values are for use in the weighted accident procedure.

Table A6.3(a) Urban roundabout injury accident prediction model parameters (per approach - 2006)

Number of entry lanes per approach	Single		Multiple	
	b_0	b_1	b_0	b_1
Roundabout	5.56×10^{-4}	0.58	9.19×10^{-4}	0.58

Table A6.3(b) Urban roundabout injury accident prediction model flow ranges (per approach) and k values

Number of entry lanes per approach	Single		Multiple	
	Flow range AADT	k value	Flow range AADT	k value
Roundabout	170 - 25000	2.2	800 - 42000	2.2

A6.5 Typical injury accident rates and prediction models, continued

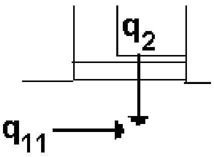
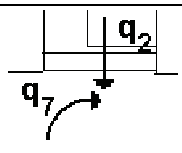
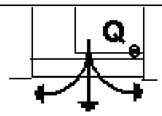
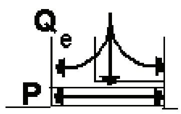
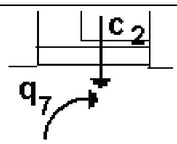
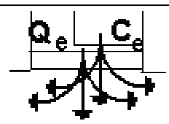
(3)

Conflict - urban signalised crossroads, < 80 km/h

The conflicting flow models for signalised crossroads are suitable for situations where a breakdown of accidents by accident and road user type is required, or where the proportion of turning vehicles is high compared to through vehicles.

For urban (speed limit < 80 km/h) signalised crossroads on the primary road network the typical accident rates can be calculated for the six accident types (13, 19) in table A6.4(a).

Table A6.4(a) Urban signalised crossroad accident prediction models types

Accident types	Variables		CAS movement categories
Crossing (no turns, motor vehicle only)		$q_{2/11}$ = Through vehicle flows in veh/day	HA
Right turn against (motor-vehicle only)		q_2 = Through vehicle flow in veh/day q_7 = Right-turning vehicle flow in veh/day	LA, LB
Others (motor-vehicle only)		Q_e = Entering vehicle flow in veh/day	-
Pedestrian versus motor vehicle		Q_e = Entering vehicle flow in veh/day P = Pedestrian crossing volume in ped/day	NA-NO, PA-PO
Right turn against (cyclist travelling through)		q_7 = Right-turning vehicle flow in veh/day c_2 = Through cycle flow in cyc/day	LA, LB
Others (cyclist versus motor vehicle)		Q_e = Entering vehicle flow in veh/day C_e = Entering cycle flow in cyc/day	-

A6.5 Typical injury accident rates and prediction models, continued

(3)

Conflict - urban signalised crossroads, < 80 km/h, continued

The number of reported injury accidents per year for each accident type on each approach can be calculated using the models in table A6.4(b). These models calculate the number of accidents per approach and therefore must be used for each approach to the intersection.

Table A6.4(b) Urban signalised crossroad accident prediction models (per approach - 2006)

Accident Types	Model	k value
Crossing (no turns, motor vehicle only)	$A_T = 1.06 \times 10^{-4} \times q_2^{0.36} \times q_{11}^{0.38}$	1.1
Right turn against (motor-vehicle only)	$A_T = 6.48 \times 10^{-5} \times q_2^{0.49} \times q_7^{0.42}$	1.9
Others (motor-vehicle only)	$A_T = 2.45 \times 10^{-4} \times Q_e^{0.59}$	5.9
Pedestrian versus motor vehicle	$A_T = 3.22 \times 10^{-2} \times Q_e^{-0.05} \times P^{0.03}$	1.4
Right turn against (cyclist travelling through)	$A_T = 3.48 \times 10^{-4} \times q_7^{0.34} \times c_2^{0.20}$	1.3
Others (cyclist versus motor vehicle)	$A_T = 1.42 \times 10^{-3} \times Q_e^{0.28} \times C_e^{0.03}$	1.1

A6.5 Typical injury accident rates and prediction models, continued

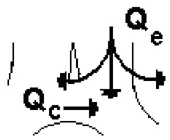
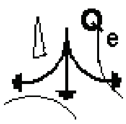
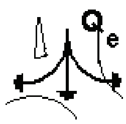
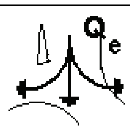
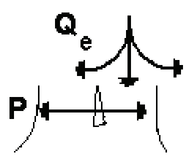
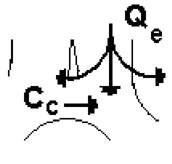
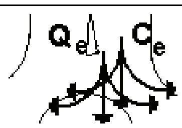
(4)

Conflict - urban roundabouts, < 80 km/h

The conflicting flow models for roundabouts are suitable for situations where a breakdown of accidents by accident and road user type is required, such as roundabouts with high proportions of cyclists.

For urban (speed limit < 80 km/h) roundabouts on the primary road network the typical accident rates can be calculated for the seven accident types (15) in table A6.5(a).

Table A6.5(a) Urban roundabout accident prediction models types

Accident types	Variables		CAS movement categories
Entering-vs-circulating (motor-vehicle only)		Q_e = Entering vehicle flow in veh/day Q_c = Circulating vehicle flow in cyc/day S_c = Mean free speed of circulating vehicles	HA, JA-JO KA-KO, LA-LO
Rear-end (motor-vehicle only)		Q_e = Entering vehicle flow in veh/day	FA-FO, GA, GD
Loss-of-control (motor-vehicle only)		Q_e = Entering vehicle flow in veh/day V_{10} = Visibility 10 m back from the limit line to vehicles on the approach to the right	CA-CO, DA-DO, AD, AF
Other (motor-vehicle only)		Q_e = Entering vehicle flow in veh/day	-
Pedestrian		Q_e = Entering vehicle flow in veh/day P = Pedestrian crossing volume in ped/day	NA-NO, PA-PO
Entering-vs-circulating (cyclist circulating)		Q_e = Entering vehicle flow in veh/day C_c = Circulating cycle flow in cyc/day S_e = Mean free speed of entering vehicles	HA, JA-JO KA-KO, LA-LO
Other (cyclist)		Q_e = Entering vehicle flow in veh/day C_e = Entering cycle flow in cyc/day	-

A6.5 Typical injury accident rates and prediction models, continued

(4)

Conflict - urban roundabouts, < 80 km/h, continued

The number of reported injury accidents per year for each accident type on each approach can be calculated using the models in Table A6.5 (b). These models calculate the number of accidents per approach and therefore must be applied at all approaches to the roundabout.

Table A6.5(b) Urban roundabout accident prediction models (per approach - 2006)

Accident types	Model	k value
Entering-vs-circulating (motor-vehicle only)	$A_T = 5.57 \times 10^{-8} \times Q_e^{0.47} \times Q_c^{0.26} \times S_c^{2.13}$	1.3
Rear-end (motor-vehicle only)	$A_T = 8.76 \times 10^{-2} \times Q_e^{-0.38} \times e^{0.00024 \times Qe}$	0.7
Loss-of-control (motor-vehicle only)	$A_T = 8.71 \times 10^{-6} \times Q_e^{0.59} \times V_{10}^{0.68}$	3.9
Other (motor-vehicle only)	$A_T = 1.99 \times 10^{-5} \times Q_e^{0.71} \times \Phi_{MEL}$ Φ_{MEL} = 2.66 (if multiple entry lanes) Φ_{MEL} = 1.00 (if single entry lane)	-
Pedestrian	$A_T = 2.93 \times 10^{-4} \times P^{0.60} \times e^{0.00013 \times Qe}$	1.0
Entering-vs-circulating (cyclist circulating)	$A_T = 3.30 \times 10^{-5} \times Q_e^{0.43} \times C_c^{0.38} \times S_e^{0.49}$	1.2
Other (cyclist)	$A_T = 4.24 \times 10^{-7} \times Q_e^{1.04} \times C_e^{0.23}$	-

A6.5 Typical injury accident rates and prediction models, continued

(5)

General urban mid-blocks, 50-70 km/h

The 'general' models are suitable for most urban mid-blocks (2 to 4 lane road) types in posted speed limit areas of 50-70 km/h. The typical accident rate (reported injury accidents per year) is dependent on roadside development, and for arterials, the presence of a median. separate pedestrian and cyclist models are available. All reported injury accidents are calculated using the model:

$A_T = b_0 \times Q_T^{b_1} \times L$

where: Q_T is the daily two-way traffic volume (AADT)
L is the length of the mid-block site

b_0 and b_1 are given in table A6.6(a). Use the commercial classification when the majority of roadside development is either commercial or industrial, while 'other' is for residential and all other types.

Table A6.6(b) shows the range of flows and speed limits over which the accident prediction models should be applied. The arterial models can be used for 50 and 60 km/h speed limit areas. The collector and local street models are applicable for 50 km/h speed limit areas only. The k values are for the weighted accident procedure.

Arterials with ≥6 lanes

There is currently no information available for six or more lane arterials. The arterial model can be used as in the weighted accident procedure (Method C) with a reliability factor, α_M, of 1.5. Six-lane roads are likely to have a greater proportion of weaving related accidents, particularly where intersections are closely spaced.

Effect of medians

A reduction of 15 percent in the accident prediction for arterial and collector mid-blocks should be applied for flush medians. A reduction of 25 percent in the accident prediction for arterial mid-blocks should be applied for raised medians. Note that raised medians can migrate accidents to adjacent intersections.

Table A6.6(a) Urban mid-block injury accident prediction model parameters (2006)

Land-use	Commercial		Other	
Mid-block road type	**b_0**	**b_1**	**b_0**	**b_1**
Local street	2.53×10^{-4}	0.98	2.53×10^{-4}	0.98
Collector	2.24×10^{-5}	1.08	3.46×10^{-5}	1.08
Arterial (2 and 4 lane)	7.66×10^{-6}	1.20	1.34×10^{-4}	0.88

Table A6.6(b) Urban mid-block injury accident prediction model flow ranges and k values

Mid-block type	Speed limit	Flow range AADT	k value	
			Commercial	**Other**
Local street	50 km/h	< 3,000	0.6	0.6
Collector	50 km/h	2,000 – 8,000	10.0	10.0
Arterial (2 and 4 lane)	50 or 60 km/h	3,000 – 24,000	8.5	10.8

A6.5 Typical injury accident rates and prediction models, continued

(6)

Conflict - urban mid-block – pedestrian and cyclist facilities

The pedestrian or cyclist models are required when using accident rate analysis to assess a new or improved pedestrian or cyclist facility. These rates are for urban (speed limit < 80 km/h) areas and do not include any pedestrian or cyclist accidents that occur at side roads. However, driveway accidents are included. The typical accident rates can be calculated for the accident types in table A6.7(a).

The number of reported injury accidents per year for each accident type is calculated using the models in table A6.7(b).

Table A6.7(a) Urban mid-block pedestrian and cycle accident prediction model types

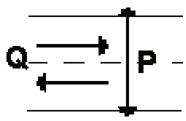
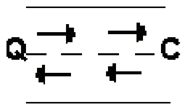
Accident types	Variables	CAS movement categories
All mid block pedestrian accidents	 Q = Two-way vehicle flow in veh/day P = Pedestrian crossing volume per 100 metres in ped/100m/day L = Segment length in km	NA-NO, PA-PO
All mid block cyclist accidents	 Q = Two-way vehicle flow in veh/day C = Two-way cycle flow in veh/day L = Segment length in km	All

Table A6.7(b) Urban mid-block pedestrian and cycle accident prediction models (2006)

Accident types	Model	k value (mid-point)
All mid block pedestrian accidents	$A_T = 1.47 \times 10^{-4} \times Q^{0.69} \times P^{0.26} \times L$	-
All mid block cyclist accidents	$A_T = 1.37 \times 10^{-7} \times Q^{1.38} \times C^{0.23} \times L$	-

A6.5 Typical injury accident rates and prediction models, continued

(7)

General high speed cross and T intersections, ≥80 km/h

The 'general' model is suitable for most high speed cross and T intersections and use two-way link volumes. Where a breakdown of accidents by accident and road user type is required, or where the proportion of turning vehicles is high compared to through vehicles then conflicting flow models should be used.

For high speed cross and T intersections, the typical accident rate (reported injury accidents per year) is calculated using the model:

$A_T = b_0 \times Q_{major}^{b_1} \times Q_{minor/side}^{b_2}$

where:

Q_{major} the highest two-way link volume (AADT) for cross-roads and the primary road volume for T-junctions

$Q_{minor/side}$ the lowest of the daily two-way link volumes (AADT) for cross-roads and the side road flow for T-junctions.

b_0, b_1 and b_2 are given in table A6.8(a).

Table A6.8(b) shows the range of flows over which the accident prediction models should be applied. The k values are for use in the weighted accident procedure.

Caution

Caution should be exercised when using the prediction models for intersections where opposing approach flows (on Q_{major} or Q_{minor}) differ by more than 25 percent. In such cases, conflicting flow models should be used.

Table A6.8(a) High speed intersection injury accident prediction model parameters (2006)

Intersection type	b_0	b_1	b_2
Priority – Cross	4.32×10^{-4}	0.39	0.50
Priority – T	4.07×10^{-4}	0.18	0.57
Traffic signals – Cross	3.64×10^{-4}	0.52	0.19
Traffic signals – T	5.10×10^{-2}	0.37	-0.10

Table A6.8(b) High speed intersection injury accident flow ranges and k values

Intersection type	Range Q_{major} AADT	Range Q_{minor} AADT	k value
Priority – Cross	50 - 24000	50 - 3500	2.6
Priority – T	50 - 26000	50 - 9000	4.7
Traffic signals – Cross	19000 - 46000	11000 - 20000	4.7
Traffic signals – T	10000 - 54000	1700 - 17000	2.0

A6.5 Typical injury accident rates and prediction models, continued

(8)

Conflict - high speed roundabout

Often roundabouts do not have the roads with the highest or lowest volumes on opposing arms, or if they have three arms these are seldom in a 'T'. Therefore, accidents are calculated for each arm of the roundabout, and the total obtained by adding these together. The typical accident rate (reported injury accidents per approach per year) is calculated using the model:

$A_T = b_0 \times Q_{approach}^{b1}$

where:

$Q_{approach}$ the two-way link volume (AADT) on the approach being examined.

b_0, and b_1 are given in table A6.9(a).

This model can be applied for roundabouts with three or four approaches. Table A6.9(b) shows the range of flows over which the accident prediction model should be applied. The k values are for use in the weighted accident procedure.

Table A6.9(a) High speed roundabout injury accident prediction model parameters (per approach - 2006)

	b_0	b_1
Roundabout	1.50×10^{-3}	0.53

Table A6.9(b) High speed roundabout injury accident prediction model flow ranges (per approach)

	Flow range AADT	k value
Roundabout	800 - 29000	2.1

A6.5 Typical injury accident rates and prediction models, continued

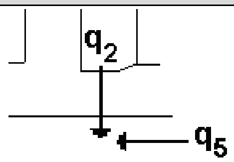
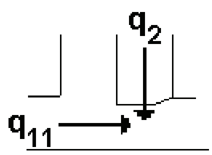
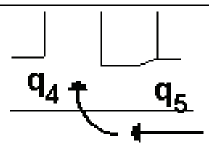
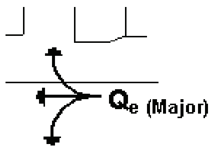
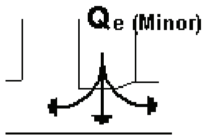
(9)

Conflict – high speed priority crossroads, > 70 km/h

The conflicting flow models for priority crossroads in high-speed areas are suitable for situations where a breakdown of accidents by accident type is required, or where the proportion of turning vehicles is high compared to through vehicles.

For high speed (speed limit > 70 km/h) priority crossroads on two-lane, two way roads the typical accident rates can be calculated for the five accident types in table A6.10(a).

Table A6.10(a) High speed priority crossroad accident prediction models types

Accident types	Variables	CAS movement categories
Crossing – hit from right (major road approaches only)	 $q_{2/5}$ = Through vehicle flows in veh/day	HA
Crossing – hit from right (minor road approaches only)	 $q_{2/11}$ = Through vehicle flows in veh/day	HA
Right turning and following vehicle (major road approaches only)	 q_5 = Through vehicle flow along major road in veh/day q_4 = Right-turning flow from major road in veh/day	GC, GD, GE
Other (major road approaches only)	 Q_e = Entering vehicle flow on major road in veh/day	-
Other (minor road approaches only)	 Q_e = Entering vehicle flow on minor road in veh/day	-

A6.5 Typical injury accident rates and prediction models, continued

(9)

Conflict – high speed priority crossroads, > 70 km/h, continued

The number of reported injury accidents per year for each accident type is calculated table A6.10(b). These models calculate the number of accidents per approach. However, unlike urban roundabout and signalised crossroad models, each model is only applied to two approaches only (not all four). These approaches are specified as either 'major road' or 'minor road' with the minor road being the road with stop or give way control.

Table A6.10(b) High speed priority crossroad accident prediction models (per approach -2006)

Accident types	Model	k value
Crossing – hit from right (major road approaches only)	$A_T = 1.15 \times 10^{-4} \times q_2^{0.60} \times q_5^{0.40}$	0.9
Crossing – hit from right (minor road approaches only)	$A_T = 1.97 \times 10^{-4} \times q_2^{0.40} \times q_{11}^{0.44}$	2.0
Right turning and following vehicle (major road approaches only)	$A_T = 1.04 \times 10^{-6} \times q_4^{0.36} \times q_5^{1.08} \times \Phi_{RTB}$ $\Phi_{RTB} = 0.22$ (if right-turn bay present) $\Phi_{RTB} = 1.00$ (if right-turn bay absent)	2.6
Other (major road approaches only)	$A_T = 1.09 \times 10^{-4} \times Q_{e(Major)}^{0.76}$	1.1
Other (minor road approaches only)	$A_T = 3.30 \times 10^{-3} \times Q_{e(Minor)}^{0.27}$	0.2

A6.5 Typical injury accident rates and prediction models, continued

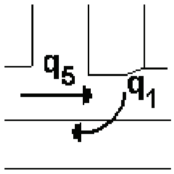
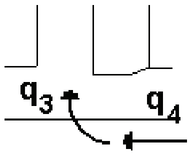
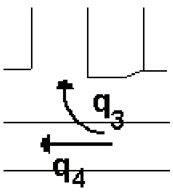
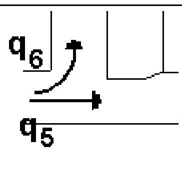
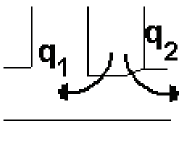
(10)

Conflict – high speed priority T-junctions, > 70 km/h

The conflicting flow models for priority T-junctions in high-speed areas are suitable for situations where a breakdown of accidents by accident type is required, where one turning movement from the side road is greater than the other, or where the intersection has a visibility deficiency.

For high speed (speed limit > 70 km/h) priority T-junctions on two lane, two way roads the typical accident rates can be calculated for the five accident types in table A6.11(a).

Table A6.11(a) High speed priority T-junctions accident prediction models types

Accident types	Variables	CAS movement categories
Crossing – vehicle turning (major road approach to right of side road)	 q_5 = Through vehicle flow along major road to right of minor road vehicles in veh/day q_1 = Right-turning flow from minor road in veh/day V_D = Sum of visibility deficiency in both directions when compared with Austorads SISD (3)	JA
Right-turning and following vehicle (major road approach to left of side road)	 q_4 = Through vehicle flow along major road to right of minor road vehicles in veh/day q_3 = Right-turning flow from major road in veh/day S_L = Mean free speed of vehicles approaching from the left of vehicles minor road	GC, GD, GE
Other (major road approach to left of side road)	 q_5 = Through vehicle flow along major road to right of minor road vehicles in veh/day q_3 = Right-turning flow from major road in veh/day	-
Other (major road approach to right of side road)	 q_5 = Through vehicle flow along major road to left of minor road vehicles in veh/day q_6 = Left-turning flow from major road in veh/day	-
Other (side road approach)	 q_1 = Right-turning flow from minor major road in veh/day q_2 = Left-turning flow from minor road in veh/day	-

A6.5 Typical injury accident rates and prediction models, continued

(10)

Conflict – high speed priority T-junctions, > 70 km/h, continued

The typical accident rate (number of reported injury accidents) per year for each accident type is calculated using table A6.11(b). Unlike models for other intersections, these models are each for a specific approach.

Table A6.11(b) High speed priority T-junction accident prediction models (2006)

Accident types	Model	k value
Crossing – Vehicle turning (major road approach to right of side road)	$A_T = 5.08 \times 10^{-6} \times q_1^{1.33} \times q_5^{0.15} \times V_D^{0.33}$	8.1
Right-turning and following vehicle (major road approach to left of side road)	$A_T = 5.08 \times 10^{-27} \times q_3^{0.46} \times q_4^{0.67} \times S_L^{11}$	0.2
Other (major road approach to left of side road)	$A_T = 2.87 \times 10^{-4} \times (q_3 + q_4)^{0.51}$	3.0
Other (major road approach to right of side road)	$A_T = 1.53 \times 10^{-5} \times (q_5 + q_6)^{0.91}$	1.0
Other (side road approach)	$A_T = 1.41 \times 10^{-2} \times (q_1 + q_2)^{-0.02}$	0.6

A6.5 Typical injury accident rates and prediction models, continued

(11)

Rural two-lane roads, ≥ 80 km/h

For two-lane rural roads in 80 and 100 km/h speed limit areas, the typical accident rate (reported injury accidents per year) is calculated using the exposure-based equation:

$A_T = (b_0 \times S_{adj}) \times X$

where:

S_{adj} is the cross section adjustment factor for seal widths

X is the exposure in 100 million vehicle kilometres per year.

Coefficient b_0 is provided in table A6.12(a). The coefficient b_0 is applicable to a given mean seal width. S_{adj} is found in table A6.13, and varies according to traffic flow, seal shoulder width and lane width.

The terrain type for b_0 can be selected by analysing the route gradient data. The gradient ranges should generally be maintained throughout the road section. Portions of road that are less steep can occur in mountainous sections for short lengths. Provided that the lower gradient length is followed by another mountainous gradient, then the entire section can be classified as mountainous.

Table A6.12(b) shows the k values per kilometre that should be used in the weighted accident procedure.

Table A6.12(a) Rural mid-block equation coefficients (b_0) (2006)

AADT	Mean seal width (m)	Coefficients b_0 by terrain type		
		Level (0 to 3 %)	Rolling (>3 to 6 %)	Mountainous (> 6 %)
< 1,000	6.7	16	21	30
1,000 – 4,000	8.2	16	18	26
> 4,000	9.5	11	16	22

Table A6.12(b) Rural mid-block k values per km

AADT	k values per km by terrain type		
	Level terrain (0 to 3%)	Rolling terrain (>3 to 6%)	Mountainous terrain (> 6%)
< 1,000	0.4	0.2	0.5
1,000 – 4,000	0.8	0.2	0.5
> 4,000	0.7	0.7	1.3

A6.5 Typical injury accident rates and prediction models, continued

Applying the cross-section adjustment factors

Table A6.13 provides adjustment factors for two lane rural accident rates for various combinations of seal widths that differ from the mean seal widths in table A6.12(a).

First, the overall seal width, shoulder width and lane width is determined. Then, look up S_{adj} that corresponds to the traffic volume, shoulder width and lane width in table A6.13. Adjust b_0 by multiplying with the adjustment factor and use this value to calculate the typical accident rate.

In the case of shoulder widening, different adjustment factors must be used for the do minimum and option.

Effect of crash barriers

In mountainous and rolling terrain the typical accident rates can be reduced by 25 percent when crash barriers are installed to protect errant vehicles from drop-off areas and other obstacles in the roadside clear zone.

3-4 lane rural roads

For three and four lane rural roads refer to appendix A6.5 on passing lanes.

Worked example

An example of the use of the cross-section adjustment factors in table A6.13 is provided in appendix A6.8.

A6.5 Typical injury accident rates and prediction models, continued

Table A6.13 Cross-section adjustment factors (S_{adj})

S_{adj} for traffic flows < 1,000 vpd					
Seal shoulder width	**Lane width**				
	2.75 m	**3.00 m**	**3.25 m**	**3.50 m**	**3.60 m**
0 m	1.17	1.10	1.03	0.96	0.93
0.25 m	1.10	1.03	0.96	0.89	0.86
0.50 m	1.03	0.96	0.89	0.82	0.79
0.75 m	0.89	0.82	0.75	0.68	0.66
1.00 m	0.75	0.68	0.61	0.55	0.52
1.50 m	0.61	0.55	0.48	0.41	0.41
2.00 m	0.48	0.41	0.41	0.41	0.41
S_{adj} for traffic flows 1,000 to 4,000 vpd					
Seal shoulder width	**Lane width**				
	2.75 m	**3.00 m**	**3.25 m**	**3.50 m**	**3.60 m**
0 m	1.47	1.38	1.30	1.21	1.17
0.25 m	1.38	1.30	1.21	1.12	1.09
0.50 m	1.30	1.21	1.12	1.03	1.00
0.75 m	1.12	1.03	0.95	0.86	0.83
1.00 m	0.95	0.86	0.77	0.69	0.65
1.50 m	0.77	0.69	0.60	0.51	0.51
2.00 m	0.60	0.51	0.51	0.51	0.51
S_{adj} for traffic flows > 4,000 vpd					
Seal shoulder width	**Lane width**				
	2.75 m	**3.00 m**	**3.25 m**	**3.50 m**	**3.60 m**
0 m	2.11	2.01	1.90	1.79	1.74
0.25 m	2.01	1.90	1.79	1.67	1.58
0.50 m	1.90	1.79	1.67	1.45	1.36
0.75 m	1.79	1.67	1.45	1.22	1.18
1.00 m	1.67	1.45	1.22	1.11	1.07
1.50 m	1.22	1.11	1.00	0.89	0.85
2.00 m	1.00	0.89	0.78	0.66	0.66

A6.5 Typical injury accident rates and prediction models, continued

(12)

Rural two-lane roads: heavy vehicles, ≥ 80 km/h

For freight transport service proposals, where the road network affected by the proposal are primarily two-lane rural roads in 80 and 100 km/h rural areas, accident rate equations for accidents involving heavy vehicles can be used to estimate the change in freight related accidents.

The typical heavy vehicle accident rate (reported injury accidents involving heavy vehicles per year) is calculated using the exposure-based equation:

$A_H = b_0 X$

where: X is the exposure in 100 million heavy vehicle kilometres per year.

Coefficient b_0 is provided in table A6.14.

Table A6.14 Rural mid-block equation coefficients (b_0) for heavy vehicles (2006)

AADT	Coefficients b_0 by terrain type		
	Level terrain (0 to 3 %)	Rolling terrain (> 3 to 6 %)	Mountainous terrain (> 6 %)
≤ 4000	19	40	50
> 4000	19	19	41

A6.5 Typical injury accident rates and prediction models, continued

(13)

Motorways and 4-lane divided rural roads

The typical accident rate (reported injury accidents per year) for motorways and four-lane divided rural roads is for a one directional link only and is dependent on the one-way traffic volume.

Motorways

The typical accident rate is calculated using the model:

$A_T = b_0 \times Q_O^{b_1} \times L$

where: Q_O is the daily one-way traffic volume (AADT) on the link, and
L is the length of the motorway link.

b_0 and b_1 are given in table A6.15(a).

Table A6.15(b) shows the range of one-way flows over which the accident prediction models should be applied. The k values are for use in the weighted accident procedure.

4-lane divided rural roads

For four-lane divided rural roads, the same motorway accident prediction model is used. The b_0 coefficient from this model has been increased by 20% to take into account the presence of pedestrians, cyclists and limited access provisions of rural roads compared to motorways.

Table A6.15(a) Motorways and 4-lane divided rural roads mid-block injury accident prediction model parameters

	b_0	b_1
Motorway	2.96×10^{-7}	1.45
4-lane divided rural road	3.55×10^{-7}	1.45

Table A6.15(b) Motorways and 4-lane divided rural roads mid-block injury accident prediction model flow ranges and k values

	Flow range AADT	k value
Motorway	15,000 – 68,000	10.2
4-lane divided rural road	15,000 – 68,000	10.2

A6.5 Typical injury accident rates and prediction models, continued

(14)

Conflict - rural isolated curves, ≥ 80 km/h

Figure A6.2 and the equation below provide typical accident rates for reported injury loss of control and head-on accidents on rural curves, adjusted for the general trends in accidents. They should be used only for an isolated curve that is replaced with a single curve of a higher design speed.

The data for typical injury accident rates has been based on sealed rural state highways. An underlying assumption is that the road section under consideration is not affected by ice or other adverse factors such as poor visual conditions.

The typical accident rate (reported injury accidents per year, by CAS movement categories B, C and D) for an isolated rural curve is calculated using the equation:

$A_T = b_0 \; X \; e^{(b_1 \, S)}$

where: $b_0 = 4.1$

$b_1 = 2.0$

X is the exposure in 100 million vehicles (in one direction) passing through the curve, and

$S = 1 - \frac{\text{design speed of curve}}{\text{approach speed to curve}}$

A_T must be calculated for both directions, and S is likely to vary between the two directions. If the design speed is approximately equal to the approach speed then the equation reduces to:

$A_T = b_0 \; X$

A k value of 1.1 is used in the weighted accident procedure.

Assumptions

The following assumptions apply when using the equation or figure A6.2:

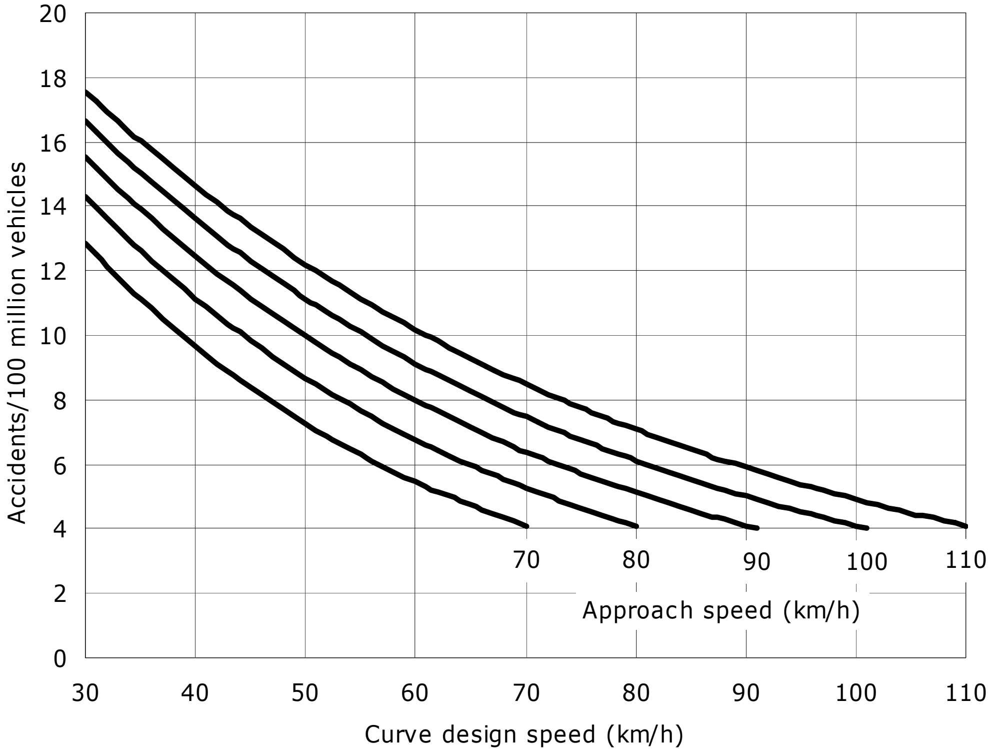
(a) for figure A6.2 the rate is in terms of injury accidents per 100 million vehicles, and for the equation the rate is in injury accidents per year through the curve

(b) the design speed of the curve should be determined from a standard design reference

(c) the approach speed to the curve is the estimated 85th percentile speed at a point prior to slowing for the curve (for longer tangents this would approximate to the speed environment).

A6.5 Typical injury accident rates and prediction models, continued

Figure A6.2 Injury accidents per 100 million vehicles for rural curves in 100 km/h speed limit areas for type B, C and D accidents (2006)



A6.5 Typical injury accident rates and prediction models, continued

(15)

Rural passing lanes accident adjustment factor

The construction of passing lanes on rural roads (posted speed limit ≥80 km/h) has the effect of reducing the typical accident rate calculated using the rural two lane roads model for both the road section and for the road downstream of the passing lane.

Where a passing lane is constructed in one direction only, for the road section alongside the passing lane, the reduction in the typical accident rate is 25% for both directions of travel. The reduction in the typical accident rate decreases linearly to zero from the end of the passing lane to either the location where vehicle platooning returns to normal (generally 5 to 10 km downstream), or where another passing lane begins.

Where passing lanes are constructed in both directions at the same location, no further accident reduction along the length of the passing lane is permitted. Downstream benefits can be calculated for either side of the section of passing lanes.

There are currently no conclusive research findings available on the upstream benefits of installing passing lanes. At this stage, no reduction in the b_0 coefficient is permitted for benefits upstream.

If a passing lane is being constructed to address a specific accident type, an appropriate accident reduction factor may be found in appendix A6.6.

A6.5 Typical injury accident rates and prediction models, continued

(16)

Single lane rural bridges, ≥ 80 km/h

The typical accident rate (reported injury accidents per year) of a single lane bridge on a rural road (≥80 km/h) is determined by the equation:

$A_T = b_0 X$

where: X is the exposure in 100 million vehicles crossing the bridge per year

$b_0 = 10.1 (Q_T)^{0.3}$ (2006 analysis year)

Q_T being the two-way daily traffic volume (AADT).

This equation does not take into account low design speed approach curves (65 km/h advisory speed or less), traffic signal control or adjoining intersections within 200 m of the bridge.

(17)

Two lane rural bridges, ≥ 80 km/h

The typical accident rate (reported injury accidents per year) of a two-lane bridge on a rural road (≥80 km/h) is determined by the equation:

$A_T = b_0 X$

where: X is the exposure in 100 million vehicles crossing the bridge per year

$b_0 = 0.96 \times c \times (0.5 - 0.25\,RW + 0.025\,RW^2)$ (2006 analysis year)

with RW being the difference between the seal width across the bridge and the total sealed lane width in metres (both directions) on the bridge approaches (normally 7 m on State highways). A narrow bridge seal width leads to a negative value for RW. The limits of RW are governed by the limiting width for single lane operation (for the maximum negative value of RW) and 2.5 m (maximum positive value of RW).

The value of c is given by the formula:

$c = e^{(3.5 - Q_T / 7,500)}$

where: Q_T is the two-way daily traffic volume (AADT).

This model does not take into account low design speed approach curves (65 km/h advisory speed or less) or adjacent intersections within 200 m of the bridge.

In the weighted accident procedure, use the k-values provided in table A6.16.

Table A6.16 Rural bridge k values

Rural bridge type	k value
Single lane bridge	0.3
Two lane bridge	0.2

A6.5 Typical injury accident rates and prediction models, continued

(18)

Urban and rural railway crossings

For urban and rural railway crossings, the typical accident rate (reported injury hit train and rear-end accidents per year) is calculated using the model:

$A_T = b_0 \times T^{b1} \times Q_T^{b2}$

where: T is the number of trains per day

Q_T is the daily two-way traffic volume (AADT)

b_0, b_1 and b_2 are given in table A6.17(a)

Table A6.17(b) shows the range of traffic volumes and trains over which the accident prediction models should be applied.

The k values are for use in the weighted accident procedure.

A large number of railway crossings are located in close proximity to low design speed curves. Low design speed approach curves are often caused by the route having to deviate sharply when crossing the railway line. In such circumstances separate predictions of the typical accident rates on these approach curves need to be made using the model for rural isolated curves (≥80 km/h).

Table A6.17(a) Railway crossing accident prediction model parameters (2006)

Control type	b_0	b_1	b_2
Half arm barriers	4.83×10^{-4}	0.27	0.33
Flashing lamps and bells	7.19×10^{-4}	0.61	0.32
No control	1.67×10^{-3}	0.31	0.36

Table A6.17(b) Railway crossing accident prediction model traffic volumes ranges and k values

Control type	Traffic volumes		k value
	Q_T AADT	Trains AADT	
Half arm barriers	< 13,000	< 40	1.8
Flashing lamps and bells	< 6,000	< 30	0.7
No control	< 1,000	< 20	2.7

A6.6 Typical accident reduction factors

Introduction

The following section provides average accident reduction factors for treatments or improvements in urban and rural areas. These reductions can be applied to the accident rate calculated using any of the three accident analysis methods.

In rural areas, accident migration should also be considered.

The reduction factors are only a guide to possible reduction rates and the evaluation documentation will need to substantiate all claimed accident reductions, particularly if they are expected to be greater than indicated here.

Typical accident reductions

The following five tables provide a typical range of injury accident reductions for mid-block and intersection treatments:

(a) in urban (speed limits of 70 km/h or less);

(b) in high speed areas (speed limits of 80 km/h or more);

(c) for cyclist and pedestrian treatments in urban areas.

When determining the accident reduction for implementing more than one measure, it is not appropriate to add all of the reduction factors together, particularly if the measures are treating similar accident types. In these cases judgement should be exercised in determining the likely overall effectiveness.

Table A6.18(a) Typical accident reductions for mid-block treatments in urban areas

Measure	Typical effectiveness of measure (% reduction)
Flush medians 50 km/h	10% to 25% of all accidents
Raised medians 50/60 km/h	25% of all accidents
Lighting – installation or upgrade	35% of night time accidents that are due to poor lighting
Ban on street parking on both sides of the street	20% of mid-block accidents. There is little research on banning parking on only one side of a street only, but some research indicates that accidents may increase.
Implementation of area wide traffic calming on local streets	25% of all accidents within the traffic calmed area.

A6.6 Typical accident reduction factors, continued

Table A6.18(b) Typical accident reductions for intersection treatments in urban areas

Measure	Typical effectiveness of measure (% reduction)
Lighting – installation or upgrade	35% of night time accidents that are due to poor lighting.
Installation of throat or fishtail islands at priority intersections	20% to 40 % of all accidents.
Establishing a right turn phase at traffic signals	10% of accidents involving right-turn-against accidents.

Table A6.18(c) Typical accident reductions for pedestrian and cyclist treatments in urban areas

Pedestrian measure	Typical effectiveness of measure (% reduction)
Kerb extensions to assist pedestrians to cross	35 % of pedestrian (type N) accidents.
Pedestrian refuges to assist pedestrians to cross	15 % of pedestrian (type N) accidents.
Pedestrian refuges and kerb extensions	30 % of pedestrian (type N) accidents.
Zebra crossings	No reduction in general and if located on a multi lane road or at a site with a speed limit of greater than 50 km/h an increase in accidents is possible.
Elevated pedestrian platforms constructed in conjunction with local traffic management or calming schemes	80 % of pedestrian (type N) accidents.
Mid-block traffic signals	45 % of pedestrian (type N) accidents, however an increase in motor-vehicle only accidents is possible if no crossing facility was previously installed.
Grade separated crossing facilities	30% of all accidents or up to 80% of pedestrian accidents depending on the extent to which pedestrians are prevented from crossing at grade.
Cyclist measure	**Typical effectiveness of measure (% reduction)**
Cycle lanes	10% of cycle accidents.
Advanced stop lines for cyclists at signalised intersections	10% of cycle accidents at signalised intersections.

A6.6 Typical accident reduction factors, continued

Table A6.18(d) Typical accident reductions for mid-block treatments in high speed areas

Measure	Typical effectiveness of measure (% reduction)
Route lighting – installation	30% of night-time accidents that are due to poor lighting.
Passing lanes or crawler lanes (ie, passing lanes on an uphill gradient)	30% of overtaking accidents within passing lane. 40% to 60% of head on accidents within passing lane. 15% of rear-end/obstruction accidents within passing lane. Reduce these percentages linearly to zero for accidents following the passing lane up to 5 km away. Ensure loss of control accidents do not increase due to design
Shoulder widening	0% to 20% of loss of control and overtaking accidents on straights from shoulder widening alone. 0% to 20% of loss of control, overtaking and head-on accidents on bends from shoulder widening alone. 0% to 40% of loss of control, overtaking and head-on accidents on bends if sight-rails and traffic signs are installed at the same time as shoulder widening.
Guardrailing	Accident reduction in terms of changed severity: 40% reduction in fatal accidents. 30% reduction in serious accidents. 10% reduction in minor accidents.
Resurfacing of curves	Compare injury accident rate at site with typical injury accident rate and injury accident rates at other local sites that are considered satisfactory.
Installation of reflective raised pavement markers	6% of all accidents.
Installation of edge marker posts	30% to 40% of off-road on curve and loss-of control on curve accidents.
Edge lines where none previously existed	8% of all accidents.
Marking no-overtaking lines missing from a section of road where they are deemed necessary	50% to 60% reduction in head-on accidents. 40% to 60% reduction in overtaking accidents.
Marking centrelines where none previously existed	13% of all accidents providing that seal width is sufficient.
Installation of audible edge lines (rumble strip/vibraline)	11% of all accidents.
Implementation of clear zones where there were previously hazards within 6 metres of the roadway	35% of loss of control and off the road accidents.

A6.6 Typical accident reduction factors, continued

Table A6.18(e) Typical accident reductions for intersection treatments in high speed areas

Measure	Typical effectiveness of measure (% reduction)
Intersection lighting – installation or upgrade	30% to 50% of night-time accidents at intersections that are due to poor lighting.
Right turn bays and associated seal widening at priority intersections	75 % of accidents involving vehicles turning right from the main road and those travelling in the same direction.
Installation of throat or fishtail islands at intersections	35 % of intersection accidents.
Installing advance warning of intersections where it is deemed necessary	7% of all intersection accidents.
Conversion of rural cross-road to two rural T-junctions (100 m plus stagger)	Reduction (or increase) depends on traffic flows. Use accident prediction models for two T-junctions to determine the benefits.

Accident migration

Accident migration downstream of the treated site is normally not an issue in the urban road environment (50 km/h to 70 km/h). Accident migration is more prevalent on rural roads and in close proximity to the site being treated. The migration of accidents from the improved site down to the next curve or substandard road element (eg, narrow bridge) is more likely than migration to a similar element 20 km downstream.

To assess the possibility of accident migration, 1 to 2 kilometres either side of the study area should be considered. If road elements, such as low design speed curves (75 km/h or less), narrow bridges and railway crossings occur within this 1 to 2 kilometres, the analysis should assess whether an increase in travel speeds through the project area will increase accidents at the adjoining road elements. If there is an expected increase in the accident occurrence then either:

1. the negative benefits need to be included in the economic evaluation
2. improvements need to be made to downstream road elements to eliminate or reduce the accident migration
3. a reduced estimate of accident savings should be used in the analysis.

A similar exercise should be undertaken for a longer length, up to 5 km either side of the study area, if the speed change from the site improvements is expected to influence speeds and driver perception over a wider area. This may be the case for major realignments.

A6.7 Adjusting accident costs to reflect mean speeds

Effect of speed on accident costs

Evidence indicates that injuries per accident and injury severity increase linearly with speed. To account for this in an accident analysis, the accident costs for the do minimum and the option(s) are calculated using mean traffic speeds.

Adjusting accident costs by movement and vehicle involvement

Accident costs by movement and vehicle involvement for use in Method A are provided for 50 km/h speed limits and 100 km/h speed limits in table A6.21(a) to (h).

Where the mean speed of the do minimum and/or project options differ from these speeds, the accident costs are adjusted using the following formula:

$C_V = C_{50} + (C_{100} - C_{50})(V - 50)/50$

where: C_V is the cost of accidents for the mean speed V

C_{50} is the cost of accidents in 50 km/h speed limit areas

C_{100} is the cost of accidents in 100 km/h speed limit area

V is the mean speed of traffic in km/h

Adjusting reported injury accident costs

Costs per reported injury accident for use in Method B or C are provided for 50, 70 and 100 km/h speed limits in table A6.22.

Where the mean speed of the do minimum and/or project options differ from these speeds, the accident costs are adjusted using the one of the following formulae:

for $50 < V < 70$ km/h: $C_V = C_{50} + (C_{70} – C_{50})(V - 50)/20$

for $70 < V < 100$ km/h: $C_V = C_{70} + (C_{100} - C_{70})(V - 70)/30$

where: C_V is the cost of accidents for the mean speed V

C_{50} is the cost of accidents in 50 km/h speed limit areas

C_{70} is the cost of accidents in 70 km/h speed limit areas

C_{100} is the cost of accidents in 100 km/h speed limit area

V is the mean speed of traffic in km/h

Calculation of mean speed

If the road section has a design speed based on the 85th percentile speed then to convert the design speed to the mean speed use the approximation of dividing the 85th percentile speed by 1.13 (or multiplying by 0.885) and round the result to the nearest whole kilometre per hour.

Mean speed should be established over a section length of at least 1 kilometre.

A6.8 Worked example of accident procedures

Introduction

This section provides a worked example using Methods B and C.

Do minimum accident costs

A straight and flat 3.3 km section of near rural road in a 100 km/h area is identified as having a high incident of loss of control accidents. This section of road has two 3.5 m lanes and no sealed shoulder. The AADT is 2,800 with a traffic growth rate of 4 percent. Nine injury accidents were recorded in CAS for the previous five years. Two of these were serious injury accidents.

The option is to widen the seal to 9 m in total: two 3.5 m lanes and 1 m wide sealed shoulders. Time zero is 2006.

The weighted accident procedure is used as there are less than three injury accidents, or one serious or fatal accident, per kilometre in the previous five years. Exposure-based accident prediction equations are available for the do minimum and option (appendix A6.5).

The proposed improvement (seal widening) is not considered a fundamental change, and hence the accident history is still relevant in calculating the site specific accident rate and costs.

Do minimum

Site specific accident rate A_S

A_S = 9 injury accidents / 5 years for the site history × 1.10

where: 1.10 is the accident trend adjustment factor from table A6.1(a)

A_S = 9 / 5 × 1.10 = 1.98 accidents per year

Typical accident rate A_T

A_T = $(b_0 \times S_{adj}) \times X$ (from appendix A6.5, rural two lane roads)

where: coefficient b_0 = 16 from table A6.12(a), for a mean seal width of 8.2 m, for 1,000 to 4,000 AADT on level terrain

Exposure (X) = 3.3 km × 2,800 AADT × 365 / 10^8 = 0.034

S_{adj} = 1.21 from table A6.13. This adjusts b_0 upward, because the current seal width of 7 m is narrower than the mean seal width of 8.2 m for a road that carries 1,000 to 4,000 vehicles per day.

$A_{T,dm}$ = 16 × 0.034 × 1.21 = 0.66 accidents per year.

No adjustment is required for time zero as year zero is 2006.

A6.8 Worked example of accident procedures, continued

Do minimum accident costs, continued

Weighted accident rate A_W for the do minimum

The weighted accident rate equation from appendix A6.3 is:

$A_{W,dm} = w \times A_T + (1 - w) \times A_S$

$w = \dfrac{\alpha_X^2 \times k}{\alpha_X^2 \times k + \alpha_M^2 \times A_T}$

The accident history at this site is considered reliable and so is the typical accident rate, therefore α_X and α_M are both equal to one, and the equation for w reduces to:

$w = \dfrac{k}{k + A_T}$ with k = 0.8 (from table A6.12(b))

Because k is per kilometre, A_T needs to be divided by the site length (3.3 km), therefore A_T = 0.66 / 3.3 = 0.200

$w = \dfrac{0.8}{0.8 + 0.200} = 0.80$

Therefore the weighted accident rate is:

$A_{W,dm}$ = 0.80 × 0.66 + (1 – 0.80) × 1.98

= 0.92 accidents per year

Do minimum accident costs

= 0.92 × $555,000 (from table A6.22)

= $510,600 per year

Option (a) accident costs: no significant changes at site

Typical accident rate A_T

$A_{T,opt}$ = b_0 × exposure × cross-section adjustment factor

= 16 × 0.034 × 0.69 = 0.38 accidents per year

where: the cross-section adjustment factor from table A6.13 adjusts b_0 downwards as the proposed seal width of 9 m is wider than the mean seal width of 8.2 m (for a road with 1,000 to 4,000 vehicles per day).

Weighted accident rate A_W for the option

$A_{W,opt}$ = $A_{T,opt} \times A_{W,dm} / A_{T,dm}$ (from appendix A6.3)

= 0.38 × 0.92 / 0.66 = 0.53 accidents per year

Option (a) accident costs

= 0.53 × $555,000

= $294,150 per year

Option (a) accident benefits

= $510,600 - $294,150

= $216,450 per year

A6.8 Worked example of accident procedures, continued

Option (b) accident costs: site significantly changed

If the proposed improvement is considered a fundamental change, in this case due to other works such as the protection of steep drop-offs or removal of obstacles in the roadside clear zone, then the site specific accident history used in the weighted accident procedure (Method C) is not relevant in the calculation of the option accident rate and costs. When there is a fundamental change the accident costs for the option are calculated using Method B.

Typical accident rate A_T for option

$A_{T,opt}$ = b_0 × exposure × cross-section adjustment factor

= 16 × 0.034 × 0.69 = 0.38 accidents per year

Option (b) accident costs

= 0.38 × $555,000

= $210,900 per year

Option (b) accident benefits

= $510,600 – $210,900

= $299,700 per year.

A6.9 Tables

Introduction

Tables A6.19 to A6.22 are for use in the worksheets provided chapter 5 of this manual. These tables are used for calculating annual accident costs, depending on which of the accident analysis procedures is used.

Tables A6.19 through to A6.21 are for use with Method A, accident-by-accident analysis, while Table A6.22 is for use with Methods B and C, accident rate analysis and the weighted accident procedure.

Table A6.19(a), (b) and (c) – Ratio of fatal to serious accident severities by movement for different speed limits.

Table A6.20(a) – Factors for converting from reported injury accidents to total injury accidents.

Table A6.20(b) – Factors for converting from reported minor injury accidents to total non-injury accidents.

Table A6.21(a), (b), (c) and (d) – Cost per accident by movement and vehicle involvement for fatal, serious, minor and non-injury accidents in 50 km/h speed limit areas.

Table A6.21(e), (f), (g) and (h) – Cost per accident by movement and vehicle involvement for fatal, serious, minor and non-injury accidents in 100 km/h speed limit areas for use with Method A, accident-by-accident analysis.

Table A6.22 – Cost per reported injury accident.

A6.9 Tables, continued

Table A6.19(a) Ratio of fatal to serious accident severities by movement for 50 km/h speed limit areas

Movement category	CAS movement codes	Fatal/ (fatal + serious)	Serious/ (fatal + serious)
Head on	AB,B	0.13	0.87
Hit object	E	0.04	0.96
Lost control off Road	AD,CB,CC,CO,D	0.11	0.89
Lost control on road	CA	0.08	0.92
Miscellaneous	Q	0.17	0.83
Overtaking	AA,AC,AE-AO,GE	0.05	0.95
Pedestrian	N,P	0.10	0.90
Cyclist	-	0.03	0.97
Rear end, crossing	FB,FC,GD	0.07	0.93
Rear end, queuing	FD,FE,FF,FO	0.08	0.92
Rear end, slow vehicle	FA,GA-GC,GO	0.06	0.94
Crossing, direct	H	0.07	0.93
Crossing, turning	J,K,L,M	0.03	0.97
All movements		0.08	0.92

Table A6.19(b) Ratio of fatal to serious accident severities by movement for 70 km/h speed limit areas

Movement category	CAS movement codes	Fatal/ (fatal + serious)	Serious/ (fatal + serious)
Head on	AB,B	0.24	0.76
Hit object	E	0.10	0.90
Lost control off road	AD,CB,CC,CO,D	0.20	0.80
Lost control on road	CA	0.14	0.86
Miscellaneous	Q	0.30	0.70
Overtaking	AA,AC,AE-AO,GE	0.12	0.88
Pedestrian	N,P	0.30	0.70
Cyclist	-	0.14	0.86
Rear end, crossing	FB,FC,GD	0.16	0.84
Rear end, queuing	FD,FE,FF,FO	0.14	0.86
Rear end, slow vehicle	FA,GA-GC,GO	0.15	0.85
Crossing, direct	H	0.21	0.79
Crossing, turning	J,K,L,M	0.09	0.91
All movements		0.18	0.82

A6.9 Tables, continued

Table A6.19(c) Ratio of fatal to serious accident severities by movement for 100 km/h speed limit areas

Movement category	CAS movement codes	Fatal / (fatal + serious)	Serious / (fatal + serious)
Head on	AB,B	0.33	0.67
Hit object	E	0.11	0.89
Lost control off road	AD,CB,CC,CO,D	0.17	0.83
Lost control on road	CA	0.16	0.84
Miscellaneous	Q	0.34	0.66
Overtaking	AA,AC,AE-AO,GE	0.14	0.86
Pedestrian	N,P	0.45	0.55
Cyclist	-	0.25	0.75
Rear end, crossing	FB,FC,GD	0.19	0.81
Rear end, queuing	FD,FE,FF,FO	0.16	0.84
Rear end, slow vehicle	FA,GA-GC,GO	0.17	0.83
Crossing, direct	H	0.25	0.75
Crossing, turning	J,K,L,M	0.15	0.85
All movements		0.21	0.79

Table A6.20(a) Factors for converting from reported injury accidents to total injury accident

		Fatal	Serious	Minor
50, 60 and 70 km/h speed limit	Pedestrian	1.0	1.5	4.5
	Push cyclist		3.3	5.5
	Other		1.5	2.8
80 and 100 km/h speed limit (excluding motorways)	Pedestrian	1.0	1.9	7.5
	Push cyclist		4.2	9.5
	Other		1.9	4.5
100 km/h speed limit remote rural area	Pedestrian	1.0	2.3	13.0
	Push cyclist		5.0	15.9
	Other		2.3	7.5
Motorway	All	1.0	1.9	1.9
All	All	1.0	1.7	3.6

Table A6.20(b) Factor for converting from reported non-injury accidents to total non-injury accidents

Speed limit area	50,60 or 70 km/h	80 or 100 km/h	Motorway
All movements	7	18.5	7

A6.9 Tables, continued

Table A6.21(a) Cost per accident by movement and vehicle involvement for fatal injury accidents in 50 km/h speed limit areas

50 km/h speed limit fatal injury accidents		Total cost per accident ($ July 2006)					
Movement category	**CAS movement codes**	**Push cycle**	**Motor cycle**	**Bus**	**Truck**	**Car, van & other**	**All vehicles**
Head on	AB,B	3,100,000	3,350,000	3,100,000	3,200,000	4,100,000	3,750,000
Hit object	E	3,100,000	3,350,000	3,100,000	3,100,000	3,400,000	3,050,000
Lost control off road	AD,CB,CC,CO,D	3,100,000	3,350,000	3,050,000	3,150,000	3,600,000	3,550,000
Lost control on road	CA	3,100,000	3,350,000	3,100,000	3,150,000	3,450,000	3,150,000
Miscellaneous	Q	3,100,000	3,350,000	3,100,000	3,100,000	3,050,000	3,050,000
Overtaking	AA,AC,AE-AO,GE	3,100,000	3,350,000	3,100,000	3,150,000	3,450,000	3,350,000
Pedestrian/Cyclist	N,P	3,100,000	3,350,000	3,100,000	3,100,000	3,050,000	3,050,000
Rear end, crossing	FB,FC,GD	3,100,000	3,350,000	3,100,000	3,100,000	3,400,000	3,350,000
Rear end, queuing	FD,FE,FF,FO	3,100,000	3,350,000	3,100,000	3,150,000	3,450,000	3,350,000
Rear end, slow vehicle	FA,GA-GC,GO	3,100,000	3,350,000	3,100,000	3,100,000	3,400,000	3,050,000
Crossing, direct	H	3,100,000	3,350,000	3,100,000	3,100,000	3,400,000	3,300,000
Crossing, turning	J,K,L,M	3,100,000	3,350,000	3,100,000	3,200,000	3,100,000	3,150,000
All movements		3,100,000	3,350,000	3,100,000	3,150,000	3,400,000	3,350,000

Table A6.21(b) Cost per accident by movement and vehicle involvement for serious injury accidents in 50 km/h speed limit areas

50 km/h speed limit serious injury accidents		Total cost per accident ($ July 2006)					
Movement category	**CAS movement codes**	**Push cycle**	**Motor cycle**	**Bus**	**Truck**	**Car, van & other**	**All vehicles**
Head on	AB,B	325,000	340,000	370,000	410,000	480,000	450,000
Hit object	E	320,000	335,000	325,000	360,000	360,000	345,000
Lost control off road	AD,CB,CC,CO,D	340,000	335,000	330,000	415,000	385,000	380,000
Lost control on road	CA	320,000	345,000	325,000	375,000	380,000	355,000
Miscellaneous	Q	325,000	335,000	335,000	370,000	360,000	360,000
Overtaking	AA,AC,AE-AO,GE	325,000	320,000	325,000	330,000	410,000	345,000
Pedestrian/Cyclist	N,P	330,000	335,000	365,000	335,000	330,000	330,000
Rear end, crossing	FB,FC,GD	325,000	335,000	350,000	340,000	355,000	350,000
Rear end, queuing	FD,FE,FF,FO	325,000	325,000	325,000	385,000	350,000	350,000
Rear end, slow vehicle	FA,GA-GC,GO	325,000	330,000	340,000	370,000	450,000	360,000
Crossing, direct	H	325,000	335,000	370,000	375,000	395,000	375,000
Crossing, turning	J,K,L,M	325,000	335,000	330,000	360,000	370,000	345,000
All movements		325,000	335,000	335,000	370,000	370,000	360,000

A6.9 Tables, continued

Table A6.21(c) Cost per accident by movement and vehicle involvement for minor injury accidents in 50 km/h speed limit areas

50 km/h speed limit minor injury accidents		Total cost per accident ($ July 2006)					
Movement category	**CAS movement codes**	**Push cycle**	**Motor cycle**	**Bus**	**Truck**	**Car, van & other**	**All vehicles**
Head on	AB,B	17,000	16,000	24,000	31,000	25,000	25,000
Hit object	E	16,000	17,000	20,000	25,000	19,000	19,000
Lost control off road	AD,CB,CC,CO,D	18,000	15,000	16,000	34,000	21,000	21,000
Lost control on road	CA	15,000	15,000	16,000	41,000	21,000	20,000
Miscellaneous	Q	15,000	17,000	15,000	25,000	18,000	19,000
Overtaking	AA,AC,AE-AO,GE	17,000	17,000	18,000	26,000	22,000	20,000
Pedestrian/Cyclist	N,P	22,000	18,000	19,000	30,000	18,000	18,000
Rear end, crossing	FB,FC,GD	15,000	18,000	16,000	30,000	21,000	21,000
Rear end, queuing	FD,FE,FF,FO	16,000	17,000	18,000	30,000	22,000	23,000
Rear end, slow vehicle	FA,GA-GC,GO	16,000	16,000	18,000	27,000	21,000	20,000
Crossing, direct	H	17,000	18,000	21,000	31,000	24,000	23,000
Crossing, turning	J,K,L,M	16,000	17,000	17,000	30,000	23,000	21,000
All movements		17,000	18,000	18,000	30,000	21,000	21,000

Table A6.21(d) Cost per accident by movement and vehicle involvement for non-injury accidents in 50 km/h speed limit areas

50 km/h speed limit non-injury accidents		Total cost per accident ($ July 2006)					
Movement category	**CAS movement codes**	**Push cycle**	**Motor cycle**	**Bus**	**Truck**	**Car, van & other**	**All vehicles**
Head on	AB,B	1,000	1,100	4,200	5,900	2,000	2,400
Hit object	E	1,000	1,100	4,900	5,800	2,000	2,500
Lost control off road	AD,CB,CC,CO,D	900	1,400	2,000	5,200	1,200	1,300
Lost control on road	CA	700	1,100	1,100	5,400	1,500	1,700
Miscellaneous	Q	1,000	1,100	5,500	5,300	1,600	2,500
Overtaking	AA,AC,AE-AO,GE	1,500	1,300	3,100	5,900	2,100	2,800
Pedestrian/Cyclist	N,P	500	1,100	200	4,900	1,100	1,200
Rear end, crossing	FB,FC,GD	1,400	1,100	2,500	5,800	2,000	2,200
Rear end, queuing	FD,FE,FF,FO	1,200	1,100	3,400	5,900	2,000	2,200
Rear end, slow vehicle	FA,GA-GC,GO	1,100	1,100	3,000	5,900	2,000	2,500
Crossing, direct	H	1,000	1,000	3,400	5,900	1,900	2,100
Crossing, turning	J,K,L,M	1,000	1,100	2,400	5,800	2,000	2,200
All movements		1,000	1,100	2,800	5,800	1,800	2,100

A6.9 Tables, continued

Table A6.21(e) Cost per accident by movement and vehicle involvement for fatal injury accidents in 100 km/h speed limit areas

100 km/h speed limit fatal injury accidents		Total cost per accident ($ July 2006)					
Movement category	**CAS movement codes**	**Push cycle**	**Motor cycle**	**Bus**	**Truck**	**Car, van & other**	**All vehicles**
Head on	AB,B	3,100,000	3,650,000	3,950,000	4,000,000	4,500,000	4,300,000
Hit object	E	3,100,000	3,550,000	3,400,000	3,850,000	3,700,000	3,550,000
Lost control off road	AD,CB,CC,CO,D	3,100,000	3,550,000	3,100,000	3,350,000	3,600,000	3,550,000
Lost control on road	CA	3,100,000	3,550,000	3,400,000	3,850,000	3,850,000	3,800,000
Miscellaneous	Q	3,100,000	3,550,000	3,400,000	3,750,000	3,250,000	3,300,000
Overtaking	AA,AC,AE-AO,GE	3,100,000	3,550,000	3,200,000	3,100,000	3,800,000	3,300,000
Pedestrian/Cyclist	N,P	3,100,000	3,550,000	3,400,000	3,100,000	3,100,000	3,100,000
Rear end, crossing	FB,FC,GD	3,100,000	3,550,000	3,400,000	3,850,000	3,850,000	3,700,000
Rear end, queuing	FD,FE,FF,FO	3,100,000	3,550,000	3,400,000	3,800,000	3,850,000	3,800,000
Rear end, slow vehicle	FA,GA-GC,GO	3,050,000	3,550,000	3,400,000	3,150,000	3,850,000	3,250,000
Crossing, direct	H	3,100,000	3,550,000	3,400,000	4,400,000	3,650,000	3,900,000
Crossing, turning	J,K,L,M	3,100,000	3,550,000	3,200,000	4,000,000	3,750,000	3,750,000
All movements		3,100,000	3,550,000	3,400,000	3,800,000	3,850,000	3,800,000

Table A6.21(f) Cost per accident by movement and vehicle involvement for serious injury accidents in 100 km/h speed limit areas

100 km/h speed limit serious injury accidents		Total cost per accident ($ July 2006)					
Movement category	**CAS movement codes**	**Push cycle**	**Motor cycle**	**Bus**	**Truck**	**Car, van & other**	**All vehicles**
Head on	AB,B	325,000	405,000	360,000	435,000	535,000	495,000
Hit object	E	330,000	370,000	320,000	380,000	370,000	360,000
Lost control off road	AD,CB,CC,CO,D	320,000	375,000	335,000	375,000	385,000	375,000
Lost control on road	CA	330,000	375,000	345,000	390,000	445,000	415,000
Miscellaneous	Q	325,000	370,000	345,000	375,000	345,000	355,000
Overtaking	AA,AC,AE-AO,GE	325,000	325,000	370,000	425,000	395,000	390,000
Pedestrian/Cyclist	N,P	330,000	370,000	345,000	335,000	350,000	350,000
Rear end, crossing	FB,FC,GD	330,000	370,000	365,000	400,000	435,000	415,000
Rear end, queuing	FD,FE,FF,FO	330,000	370,000	395,000	355,000	385,000	375,000
Rear end, slow vehicle	FA,GA-GC,GO	335,000	370,000	350,000	385,000	420,000	380,000
Crossing, direct	H	330,000	370,000	330,000	390,000	460,000	435,000
Crossing, turning	J,K,L,M	325,000	330,000	370,000	400,000	420,000	405,000
All movements		330,000	370,000	345,000	400,000	415,000	405,000

A6.9 Tables, continued

Table A6.21(g) Cost per accident by movement and vehicle involvement for minor injury accidents in 100 km/h speed limit areas

100 km/h speed limit minor injury accidents		Total cost per accident ($ July 2006)					
Movement category	**CAS movement codes**	**Push cycle**	**Motor cycle**	**Bus**	**Truck**	**Car, van & other**	**All vehicles**
Head on	AB,B	19,000	20,000	21,000	31,000	28,000	28,000
Hit object	E	18,000	19,000	15,000	30,000	20,000	21,000
Lost control off road	AD,CB,CC,CO,D	18,000	19,000	16,000	34,000	22,000	22,000
Lost control on road	CA	18,000	19,000	18,000	32,000	25,000	24,000
Miscellaneous	Q	18,000	18,000	16,000	22,000	20,000	21,000
Overtaking	AA,AC,AE-AO,GE	17,000	16,000	19,000	27,000	21,000	22,000
Pedestrian/Cyclist	N,P	18,000	19,000	18,000	30,000	18,000	19,000
Rear end, crossing	FB,FC,GD	17,000	18,000	20,000	31,000	27,000	27,000
Rear end, queuing	FD,FE,FF,FO	20,000	16,000	18,000	31,000	23,000	23,000
Rear end, slow vehicle	FA,GA-GC,GO	16,000	15,000	22,000	28,000	23,000	24,000
Crossing, direct	H	18,000	18,000	20,000	31,000	29,000	29,000
Crossing, turning	J,K,L,M	17,000	17,000	19,000	31,000	27,000	27,000
All movements		18,000	19,000	18,000	32,000	23,000	24,000

Table A6.21(h) Cost per accident by movement and vehicle involvement for non-injury accidents in 100 km/h speed limit areas

100 km/h speed limit non-injury accidents		Total cost per accident ($ July 2006)					
Movement category	**CAS movement codes**	**Push cycle**	**Motor cycle**	**Bus**	**Truck**	**Car, van & other**	**All vehicles**
Head on	AB,B	1,200	1,600	4,300	7,700	2,500	3,500
Hit object	E	1,200	1,600	3,200	6,800	1,500	2,400
Lost control off road	AD,CB,CC,CO,D	1,200	1,300	1,100	6,300	1,300	1,600
Lost control on road	CA	1,200	1,300	800	6,700	1,700	2,600
Miscellaneous	Q	1,200	1,300	6,700	6,500	1,700	3,700
Overtaking	AA,AC,AE-AO,GE	1,200	1,500	4,100	7,400	2,500	3,900
Pedestrian/Cyclist	N,P	1,200	1,500	2,900	6,700	1,400	2,700
Rear end, crossing	FB,FC,GD	1,200	1,300	5,100	7,700	2,400	3,000
Rear end, queuing	FD,FE,FF,FO	1,200	1,900	4,400	7,500	2,500	2,900
Rear end, slow vehicle	FA,GA-GC,GO	1,200	1,300	5,200	7,500	2,500	3,300
Crossing, direct	H	1,200	1,500	4,900	7,600	2,500	3,200
Crossing, turning	J,K,L,M	1,200	1,300	3,200	7,500	2,400	3,200
All movements		1,200	1,500	2,900	7,100	1,800	2,400

A6.9 Tables, continued

Table A6.22 Cost per reported injury accident ($ July 2006)

Accident site/type	Speed limit area			
	50 km/h	70 km/h	100 km/h near rural	100 km/h remote rural
All other sites	200,000	365,000	520,000	795,000
Mid-block accidents	225,000	425,000	555,000	840,000
Intersection accidents:				
Uncontrolled T	195,000	375,000	500,000	765,000
Roundabout	140,000	180,000	455,000	685,000
Priority T, Y	170,000	290,000	465,000	715,000
Priority X	170,000	295,000	585,000	880,000
Signalised T, Y	150,000	N/A	N/A	N/A
Signalised X	170,000	N/A	N/A	N/A
Motorway accidents			270,000	N/A
Railway crossing accidents	N/A	N/A	1,235,000	1,625,000
Rural bridge accidents	565,000	870,000	610,000	905,000
Heavy vehicle accidents	N/A	N/A	700,000	1,030,000
Cycle accidents	260,000	475,000	565,000	830,000
Pedestrian accidents	160,000	270,000	1,080,000	1,420,000

A6.10 References

References

1. D Anderson, M Muirson, T Sizemore, D Wanty, F Tate, *Review of State Highway shoulders*, Transit New Zealand, 2005.
2. Austroads, *Rural road design: A guide to the geometric design of rural roads,* Sydney, Australia, 2003.
3. Austroads, *Guide to traffic engineering practice – Part 5: Intersections at grade,* Sydney, Australia, 2005.
4. R Elvik, T Vaa, *The handbook of road safety measures,* Elsevier, Norway, 2004.
5. E Hauer, J C N Ng, J Lovell, *Estimation of safety at signalised intersections,* Transportation Research Record 1185: pp 48-61, 1989.
6. G F Koorey, F N Tate, *Review of accident analysis procedures for project evaluation manual,* Transfund New Zealand research report 85, 1997.
7. Land Transport New Zealand, *A New Zealand guide to the treatment of crash locations,* 2005.
8. Land Transport New Zealand, *Cycle network and route planning guide,* 2004.
9. Land Transport New Zealand, *Crash reduction study monitoring reports,* 2004. http://www.landtransport.govt.nz/roads/crash-reduction-programme.html
10. M W McLarin, *Typical accident rates for rural passing lanes and unsealed roads,* Transfund New Zealand research report 89, 1997.
11. National Road Safety Committee, *Road Safety to 2010,* Ministry of Transport, 2003.
12. F N Tate, *Guidelines for the selection of pedestrian facilities,* Land Transport New Zealand (unpublished), 2004.
13. S A Turner, *Accident prediction models,* Transfund New Zealand research report 192, 2000.
14. S A Turner, A P Roozenburg, *Cycle safety: reducing the crash risk (draft),* Land Transport New Zealand research report, 2006.
15. S A Turner, A P Roozenburg, *Roundabout crash prediction models (draft),* Land Transport New Zealand research report, 2006.
16. S A Turner, A P Roozenburg, *Crash rates at high speed, high volume junctions,* Road Safety Trust (unpublished), 2005.
17. S A Turner, A P Roozenburg, *Crash rates at rural junctions – influence of speed and visibility,* Land Transport New Zealand (unpublished), 2006.
18. S A Turner, A P Roozenburg, *Crash rates at rural junctions – priority junctions,* Road Safety Trust (unpublished), 2005.
19. S A Turner, A P Roozenburg, T Francis, *Predicting accident rates for cyclists and pedestrians,* Land Transport New Zealand research report 289, 2006.
20. S Wilkie, F N Tate, *Safety audit of existing roads – developing a less subjective database,* Transfund New Zealand (unpublished), 2003.