iRAP Road Attribute Risk Factors

Median Type

This factsheet describes the road attribute risk factors used in the iRAP methodology for Median Type. Median Type records the road infrastructure that separates opposing traffic flows.

About risk factors

Risk factors, sometimes called crash modification factors (CMF), are used in the iRAP Star Rating methodology to relate road attributes and crash rates. Risk factors (or CMF) are described by the Crash Modification Factor Clearing House as follows:

> *A crash modification factor (CMF) is a multiplicative factor used to compute the expected number of crashes after implementing a given countermeasure at a specific site.*
>
> *For example, an intersection is experiencing 100 angle crashes and 500 rear-end crashes per year. If you apply a countermeasure that has a CMF of 0.80 for angle crashes, then you can expect to see 80 angle crashes per year following the implementation of the countermeasure (100 x 0.80 = 80). If the same countermeasure also has a CMF of 1.10 for rear-end crashes, then you would also expect to also see 550 rear-end crashes per year following the countermeasure (500 x 1.10 = 550).*

Related documents

This factsheet should be read in conjunction with:

- *Star Rating Roads for Safety: The iRAP Methodology.*
- *Safer Roads Investment Plans: The iRAP Methodology.*
- *Star Rating and Investment Plan Coding Manual.*
- *Road Safety Toolkit (http://toolkit.irap.org).*

Risk factors

Risk factors by road attribute category, road user type and crash type

Median Type	Vehicle occupant and motorcyclist loss of control (head-on)	Vehicle occupant and motorcyclist overtaking (head-on)	Pedestrian crossing road	Vehicle occupant and motorcyclist property access point crash
Safety barrier - metal	0	0	1.0	0.7
Safety barrier - concrete	0	0	1.0	0.7
Physical median width >= 20.0m	2.0	0	1.0	0.7
Physical median width >= 10.0m to < 20.0m	10	0	1.0	0.7

Median Type	Vehicle occupant and motorcyclist loss of control (head-on)	Vehicle occupant and motorcyclist overtaking (head-on)	Pedestrian crossing road	Vehicle occupant and motorcyclist property access point crash
Physical median width >= 5.0m to < 10.0m	35	0	1.0	0.7
Physical median width >= 1.0m to < 5.0m	80	0	1.0	0.7
Physical median width >= 0m to < 1.0m	90	0	1.6	0.7
Continuous central turning lane	77	25	3.0	1.0
Centreline rumble strip (or flexipost)	90	0	2.7	1.0
Central hatching (>1m)	83	82.5	2.4	1.0
Centre line	100	100	3.0	1.0
Motorcyclist friendly barrier	0	0	1.0	0.7
One-way	0	0	1.0	0.7
Wide centre line (0.3m to 1.0m)	95	100	2.7	1.0
Safety barrier - wire rope	0	0	1.0	0.7

Selection of risk factors

The way in which opposing flows are separated affects the likelihood of severe crashes occurring. Physical barriers restrict the movement of errant vehicles across the median and physical medians reduce the potential for head-on impacts by making it less likely that they reach opposing traffic before they recover.

The iRAP methodology treats the "worst case" as two vehicles in a head-on collision, assigning a risk factor of 100 and relates other situations to that scenario. The situation with only a centre-line is therefore the worst case. Safety barriers are assumed to entirely remove that risk. By increasing width of median, the risk is reduced because the potential severity of a crash is reduced as the opportunity for braking increases. Vehicle and motorcycle values are not differentiated.

Likelihood factors are those that contribute or reduce the possibility of a driver or rider departs from the lane. In the situation of only a centre line, the driver is immediately at risk of a head-on crash. Head-on likelihood is considered to be negligible if there is a barrier or flexipost and reduced if there is central hatching or a continuous central turning lane.

The approach taken is similar to the run-off and recovering probabilities in the paved shoulder scenario, based on the RSAP curves (see primary review references).

It is recognised that a motorcyclist vaulting over the barrier is a risk, but it is considered that this is captured by the run off road drivers' side risk (barrier).

Pedestrian risk factors are estimates based on a number of elements, including the number of lanes to be crossed. They also relate to the availability and width of a sanctuary whilst crossing and the heightened risk that some carriageway configurations provide.

CMF Clearinghouse Excerpt 1 – cable barriers

- Countermeasure: Installation of cable barriers in freeway medians

CMF	CRF(%)	Quality	Crash Type	Crash Severity	Roadway Type	Area Type	Reference
0.38	62	★★★☆☆	Cross median	All	Principal Arterial Interstate	All	Olsen et al., 2011
0.56	44	★★★☆☆	All	Fatal,Serious injury	Principal Arterial Interstate	All	Olsen et al., 2011

Typically barriers perform well and therefore have low risk factors associated. See, for example, Cooner – 0.07 and

0.08 – risk factors are approaching zero for likelihood of severe injury for vehicle occupants:

> "Cable barriers are performing extremely well and have had very few cases of penetration unless there were nonstandard impact conditions. Researchers believe that the cable barriers are functioning according to their intended design and are restraining vehicles that impact them in fashions similar to NCHRP 350 crash-testing guidelines. The installation of cable barriers has produced significant benefits with a reduction of 18 fatalities and 26 incapacitating injuries in the first full year."

CMF Clearinghouse Excerpt 2 – cable barriers

– Countermeasure: Install median barrier (cable)

CMF	CRF(%)	Quality	Crash Type	Crash Severity	Roadway Type	Area Type	Reference
0.07	93	★★☆☆☆	All	Fatal	Not specified		Cooner et al., 2009
0	100	★★☆☆☆	All	Serious injury	Not Specified		Cooner et al., 2009
0.08	92	★☆☆☆☆	Head on	Fatal	Principal Arterial Interstate	Rural	Chandler, 2007

Concrete barriers are seen as better for motorcyclists that those of steel (because the former do not have posts). Cable barriers are assumed not to increase the severity of injury to motorcyclists: http://www.me.vt.edu/gabler/publications/TRB-11-3958-Motorcycle-Barriers.pdf.

Research on the presence of a raised median is assumed to show a 28% decrease in pedestrian exposure risk (http://dx.doi.org/10.3141/1828-07 King et al (2007)) where this treatment is combined with other elements of redesign.

The presence of a median (or barrier) provides a likelihood baseline of 1.

Without a median, (ie centreline or with central turning lane), risk is assumed to be increased to 3 from 2.8 (see the discussion for the attribute Number of Lanes – the notional increase again because of the bi-directional travel). Between these two extremes, risk is assumed to rise if the physical median is less than or equal to 1m (a Risk Factor of 1.6), central hatching (2.4) rumble strip or a wide solid centre line (2.7).

The presence of a median also influences risk at property access points by limiting turning movements to right in / right out (or left in / left out).

Background research and model development

The early EuroRAP work focussed on median barriers only from the perspective of the car occupant and Lynam (2012) comments on the wire rope barrier:

> "One of the most promising countermeasures for head-on and run-off-road crashes is the use of wire rope safety barriers over extended lengths of roadway (Larsson et al. 2003). Wire rope safety barriers (a type of flexible barrier) have recently been used over long lengths of roadway in Sweden, with great success in reducing median crossovers and head-on collisions (Larsson et al. 2003). Wire rope safety barriers deform and re-direct errant vehicles by absorbing the impact energy, significantly reducing severity outcomes. The use of such barriers in Sweden has been highly successful in reducing head-on and run-off-road crashes. As noted above, the 2+1 system in Sweden has produced large savings in crashes, with a reduction in fatalities of up to 90%.
>
> Elvik and Vaa (2004) suggest a crash reduction for all casualty crashes of 30%. They found the reduction was greatest for yielding types of barriers (steel and wire), but that concrete barriers resulted in an increase in casualties. This work could be developed (especially within the Safe System context) to determine the reduction in fatal and serious outcomes from the use of these types of barriers."

Risk factors in earlier versions of the iRAP model

Median Type	Likelihood (Pedestrian & Bicyclist)	Protection (Car occupant & Motorcyclist)
High quality barrier	1	0.5
Low quality barrier	1	1
Physical median width > 20 m	1	0
Physical median width 10-20 m	1	0.5
Physical median width 5-10 m	1	2.25
Physical median width 1-5m	1	3
Physical median width up to 1m	1.5	3.3
Continuous central turning lane	2	3.3
Flexible post	1.6	3.3
Central hatching	1.8	3.3
Centre line only	2	4
Motorcyclist-friendly barrier	1	0.5
One-way road	1	0

References

The following publications are the primary references used in the selection of the iRAP road attribute risk factors. A complete list of citations is available in: iRAP Road Attribute Risk Factors: Full Reference List.

Elvik, R, Hoye A, Vaa, T, and Sorensen, M. (2009). The Handbook of Road Safety Measures, Second Edition. Emerald Group Publishing Limited. ISBN 978-1-84855-250-0.

Lynam, D (2012). Development of Risk Models for the Road Assessment Programme. RAP504.12 and TRL Report CPR1293, Published by iRAP and TRL and available at: http://www.trl.co.uk and at http://www.irap.org.

Mak, K. and Sicking, D. (2003). Roadside Safety Analysis Program – Engineer's Manual. Transportation Research Board (TRB) National Cooperative Highway Research Program (NCHRP) Report 492. ISBN 0-309-06812-6.

Turner, B. Steinmetz, L., Lim, A. and Walsh, K. (2012). Effectiveness of Road Safety Engineering Treatments. AP-R422-12. Austroads Project No: ST1571.

Turner, B., Affum, J., Tziotis, M. and Jurewicz, C. (2009). Review of iRAP Risk Parameters. ARRB Group Contract Report for iRAP.

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