Safe System Infrastructure and Safe System Assessment Framework

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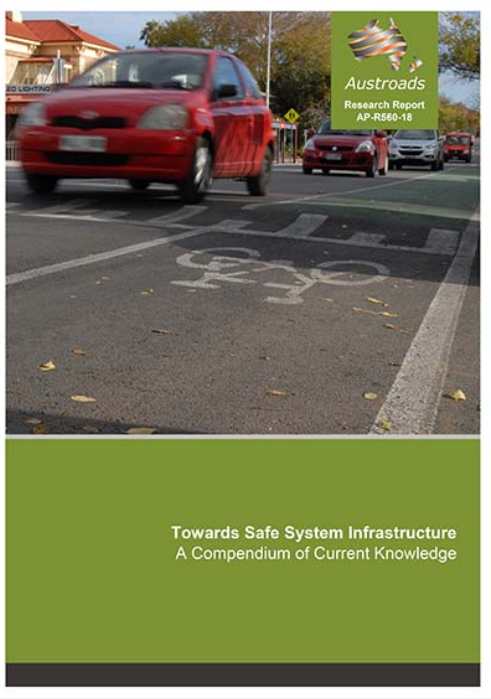
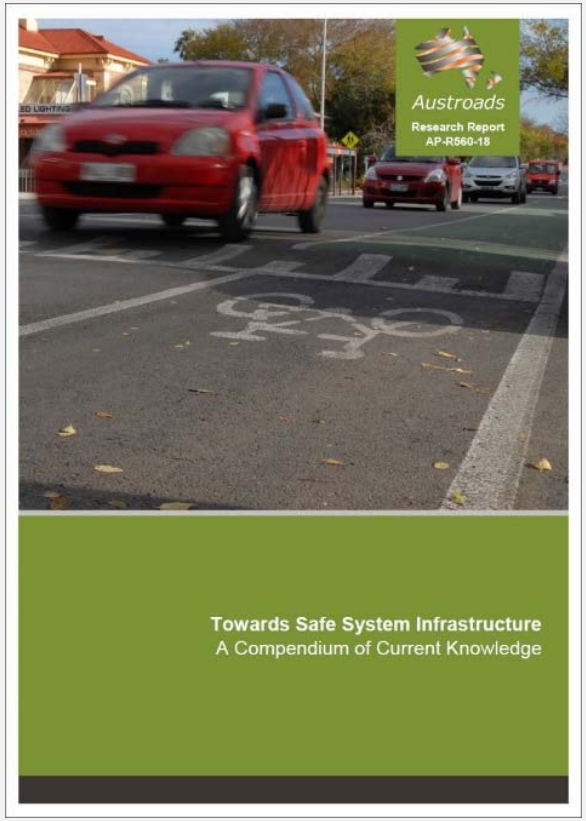
Towards Safe Systems Infrastructure: A Compendium of Knowledge



- A reference document of the latest evidence and commentary
- Aimed at practitioners who plan, design, and management the road network;
- Provides practical steps to take things forward
- Must do things differently to the past ➔ innovation is essential
- The focus is on *harm minimisation*

What the book covers?



It covers

- Introduction
- Safe System explanation
- Influence of the road environment on road user performance
- Role of speed in harm minimisation
- Intersections
- Lane departures
- Specific road user groups (VRUs)
- ITS and CAVs
- Tools and prioritisation approaches
- Resources

Treatment Hierarchy

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Primary Safe System Treatments

Supporting Treatments

Table 7.6: Safe System Assessment Framework hierarchy of heavy vehicle related treatments

Hierarchy	Treatment	Influence (E = exposure, L = likelihood, S = severity)
Safe System options ("primary" or "transformational" treatments)	• Separation (separate heavy vehicle roadways) • Very low speed environment, especially at intersections • Heavy vehicle rated barriers**	E L, S S
Supporting treatments (compatible with future implementation of Safe System options)	• Wide Centrelines	L
Supporting treatments (does not affect future implementation of Safe System options)	• Shoulder sealing and reduced edge drop to assist with heavy vehicle control	L
Other considerations	• Speed enforcement • Enforcement of other regulations • Evolve a culture of safety in organisations	L, S L L

Safe System Infrastructure Solutions: Roads and Roadsides

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Lane departure crashes

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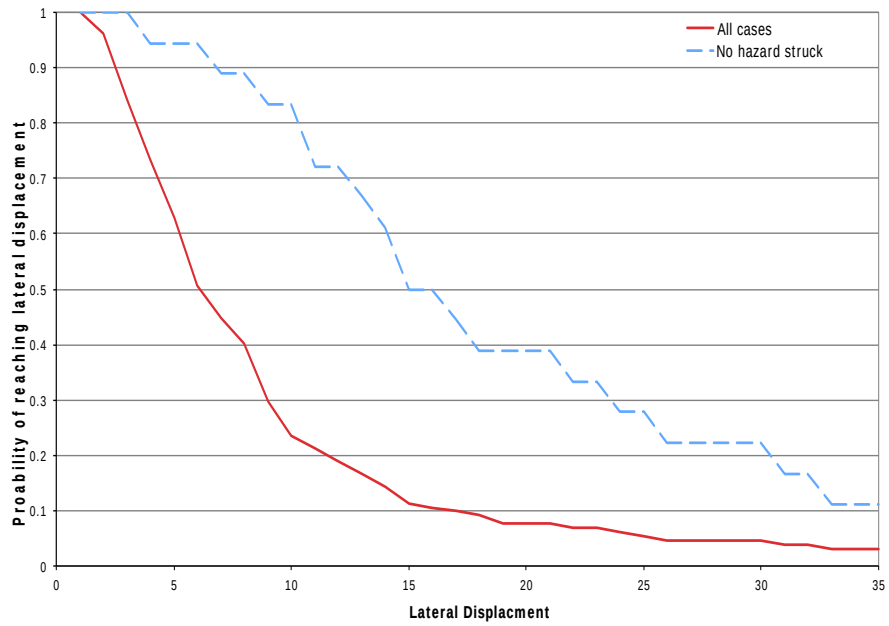
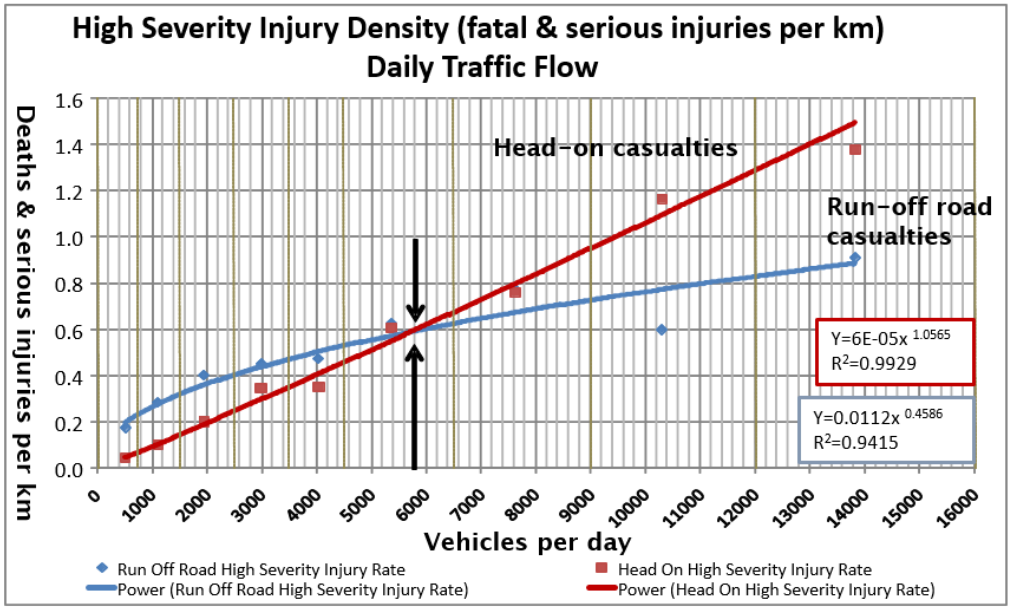
Lateral displacement



Head on versus Run off Road



Primary treatment: Roadside and median barriers to protect road users

Table 6.7: Safe System Assessment Framework hierarchy of head-on crash treatments

Hierarchy	Treatment	Influence (E = exposure L = likelihood S = severity)
Safe System options ('primary' or 'transformational' treatments)	• One-way traffic • Continuous lengths of flexible median barrier (or an equally / better performing future equivalent) • Very low operating speed.	L S S L, S
Supporting treatments (compatible with future implementation of Safe System options)	• Very wide median • Painted median / wide centrelines • Frangible delineation posts on the centreline	L L L
Supporting treatments (does not affect future implementation of Safe System options)	• wide median • Non-flexible barrier provision • Lower speed environment/speed limit • Ban overtaking • Skid resistance improvement • Audio-tactile centreline • Audio-tactile edgeline • Roadside barriers • Consistent design along the route (i.e. no out-of-context curves) • Consistent delineation for route • Overtaking lanes* • Improved superelevation.	S L, S L L L L S L L L L L L
Other considerations	• Speed enforcement • Rest area provision • Lane marking compatible with vehicle-lane-keeping technology.	L, S L L

Table 6.1: Safe System Assessment Framework hierarchy of road departure crash treatments

Hierarchy	Treatment	Influence (E = exposure L = likelihood S = severity)
Safe System options ('primary' or 'transformational' treatments)	• Continuous lengths of flexible roadside and median barriers (or an equally / better performing future equivalent) • Very low speed environment/speed limit	S L, S
Supporting treatments which move towards better Safe System alignment (compatible with future implementation of Safe System options)	• Continuous lengths of flexible roadside barriers (or an equally / better performing future equivalent) • Continuous lengths of flexible median barriers (or an equally / better performing future equivalent) • High quality well maintained run-off areas consisting of compacted roadside surface, very gentle to flat side slopes • Wide sealed shoulders with audio-tactile edgeline • Lower speed limit	S L, S L, S L L, S
Supporting treatments (does not affect future implementation of Safe System options)	• Run-off areas, with well-maintained shallow drainage and gentle side slopes • Other safety barriers types • Consistent design along the route (i.e. no out-of-context curves) • Consistent delineation for route • Skid resistance improvement • Improved superelevation • Audio-tactile centreline • Audio-tactile edgeline • Vehicle activated signs	S L L L L L L L L L L
Other considerations	• Speed enforcement • Rest area provision • Lane marking compatible with in-vehicle lane-keeping technology.	L, S L L

Safe System Infrastructure Solutions: Intersections

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Intersection crashes

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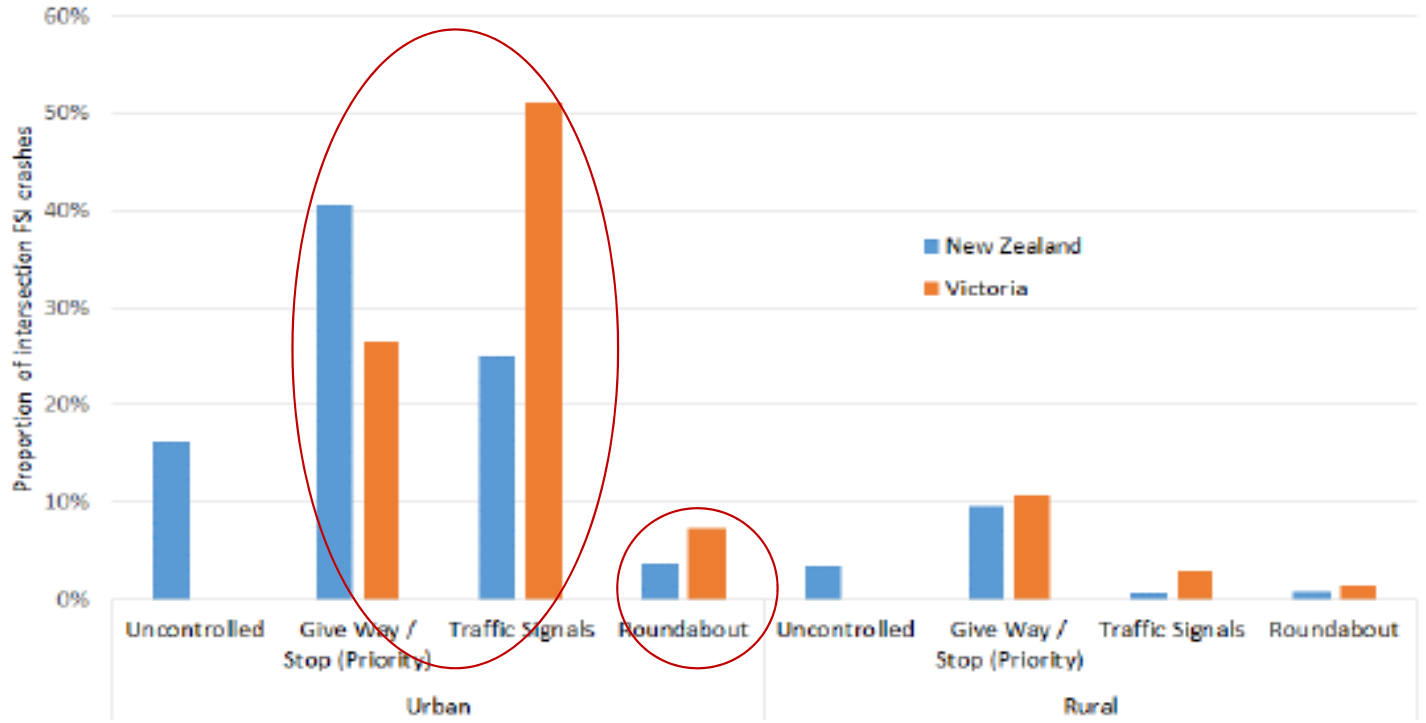
Figure 2.1: FSI crashes for different intersection types in New Zealand and Victoria



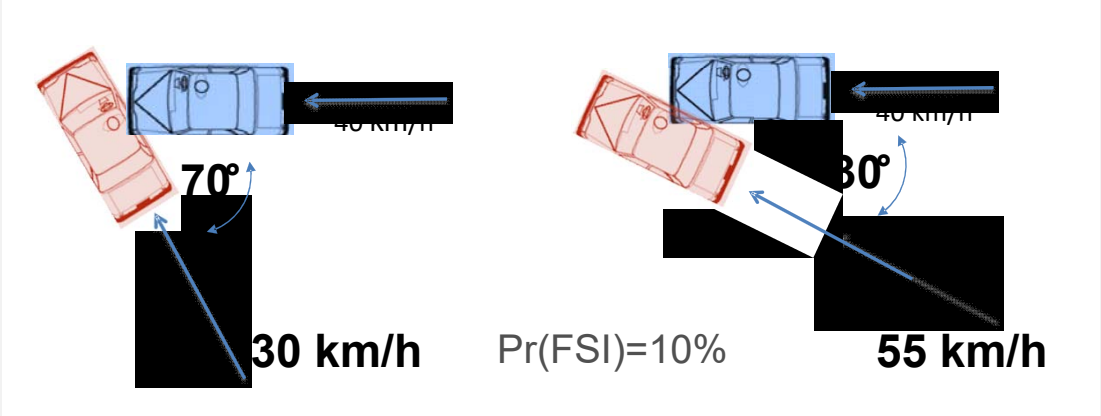
Note: Percentages relate to total of severe intersection crash sample in each jurisdiction separately.

Source: Victoria crash data 2006–2011, New Zealand CAS database 2006–2011, provided by NZTA.

Key variables regarding collisions

Energy as a function of:

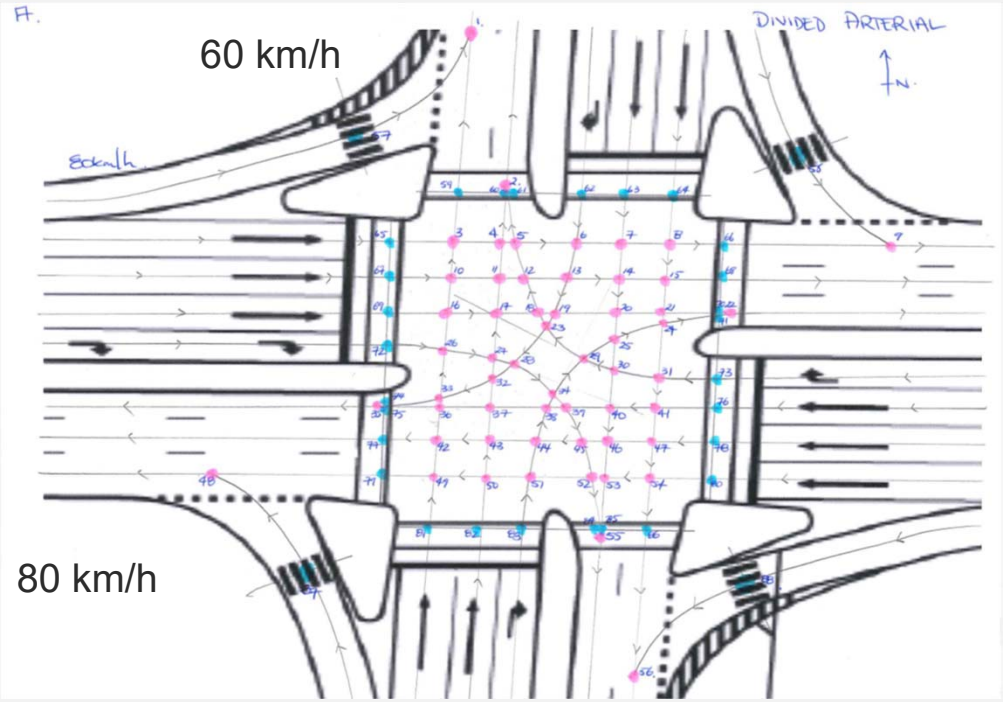
- Speed
- Mass
- Impact configuration



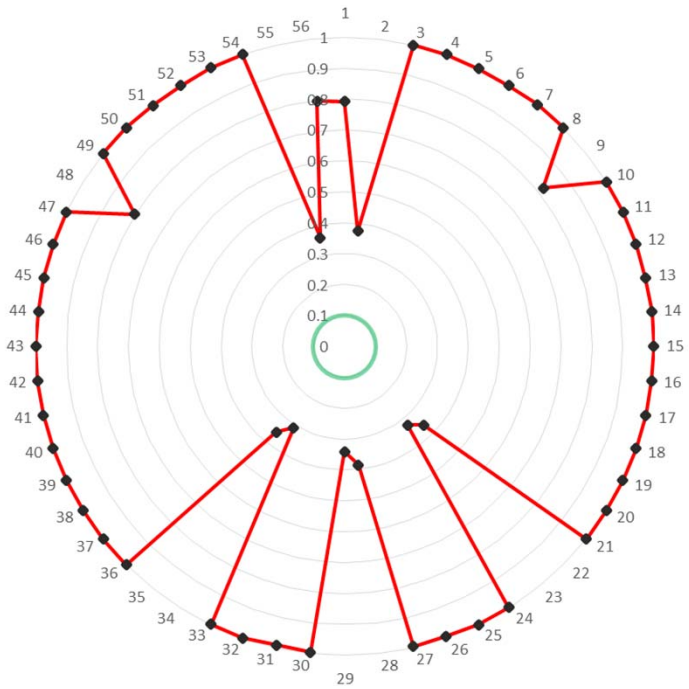
Energy model being developed

- Numerical analysis of relative FSI probabilities for a given impact angle and speed (mass equal)
- X-KEMM-X

X-KEMM-X application examples

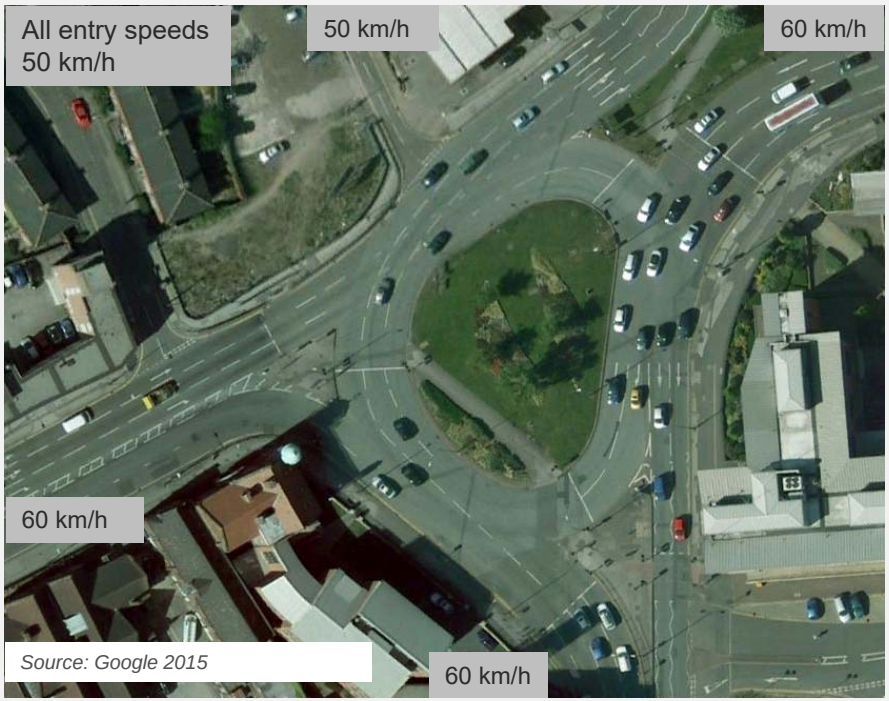


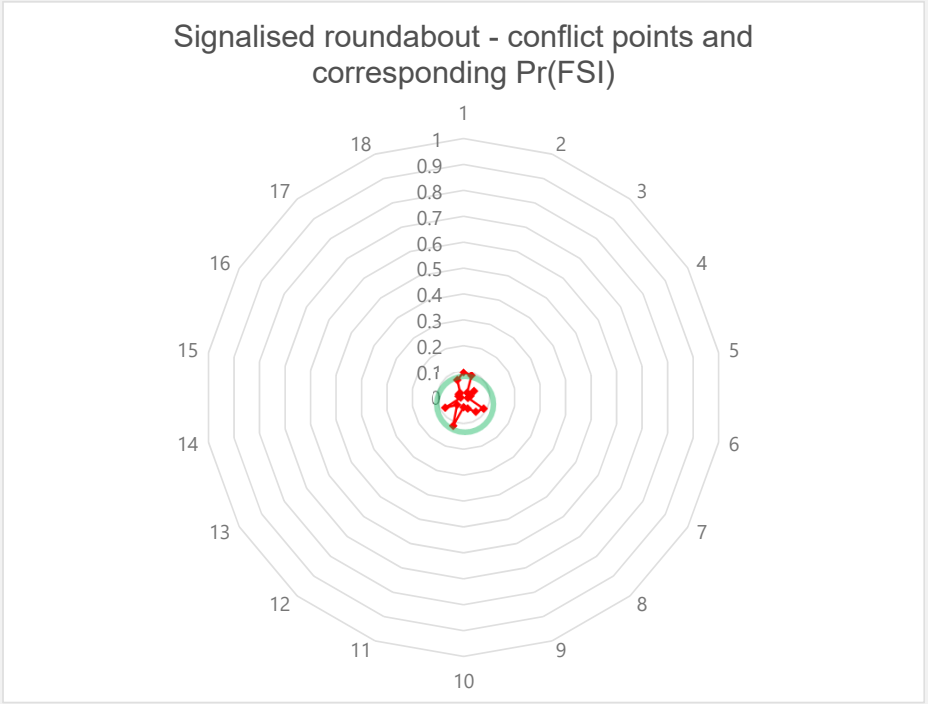
Probability of FSI injury at each conflict point



Assumes a crash will occur at full speed

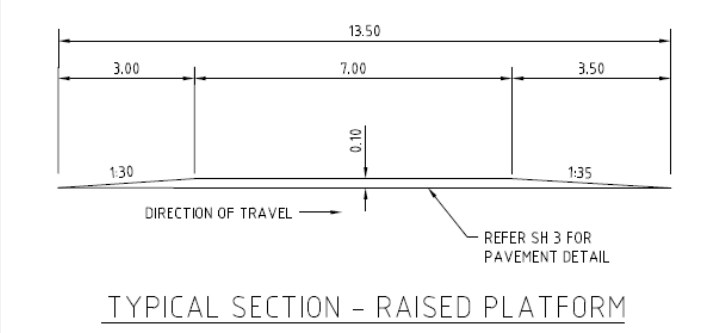
Urban signalised roundabout



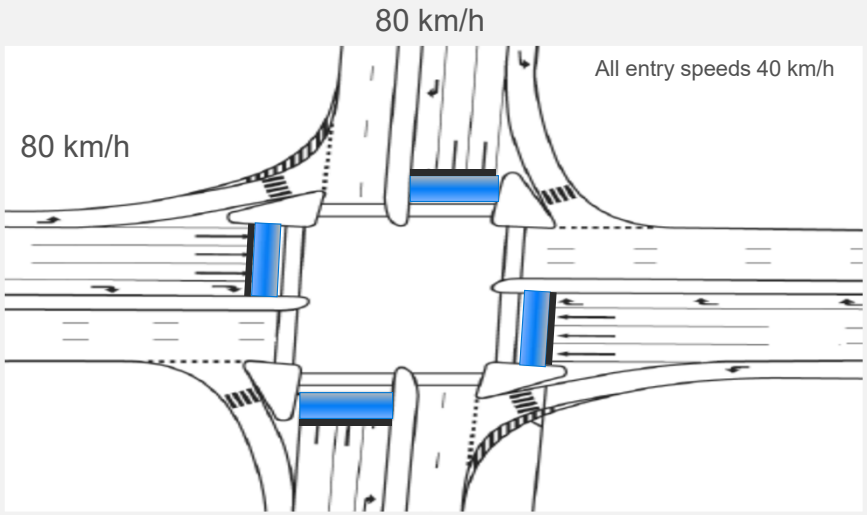


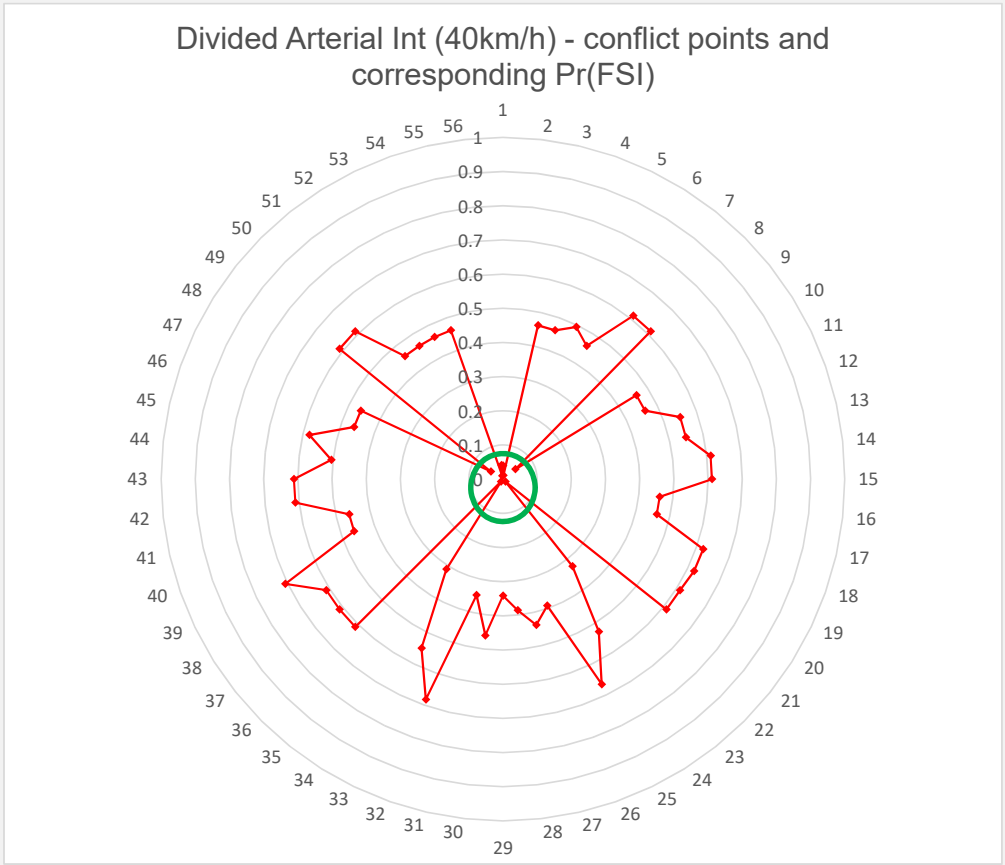
Urban signalised with vertical approach deflections

Source: VicRoads



Urban signalised with vertical approach deflections





Safe System Infrastructure Intersection Solutions

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Table 5.4: Safe System Assessment Framework hierarchy* of intersection treatments

Hierarchy	Treatment	Influence (E = exposure L = likelihood S = severity)
Safe System options ('primary' or 'transformational' treatments)	• Close intersection • Grade separation • Low speed environment/speed limit • Roundabout • Raised platform	L, S E L, S L, S L, S
Supporting treatments (compatible with future implementation of Safe System options)	• Left-in/left-out, with protected acceleration and deceleration lanes where required • Ban selected movements • Reduce speed environment/speed limit.	L, S E L, S
Supporting treatments (does not affect future implementation of Safe System options)	• Redirect traffic to higher quality intersection • Turning lanes • Vehicle activated signs • Improved intersection conspicuity • Advanced direction signage and warning • Improved sight distance • Traffic signals with fully controlled right turns • Skid resistance improvement • Improved street lighting.	E L L L L L L L L L
Other considerations	• Speed cameras combined with red light cameras • Route planning to avoid unprotected right turns	L, S E

Safe System Infrastructure Solutions: Vulnerable Road Users

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Creating liveable, vibrant and healthy cities

See Section 3

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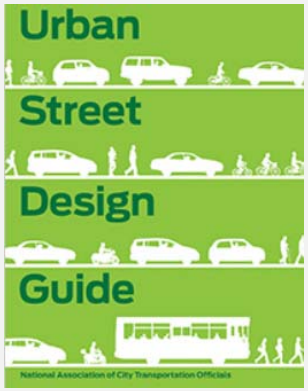
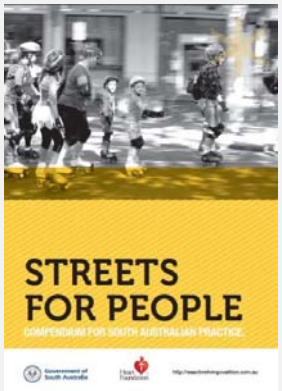
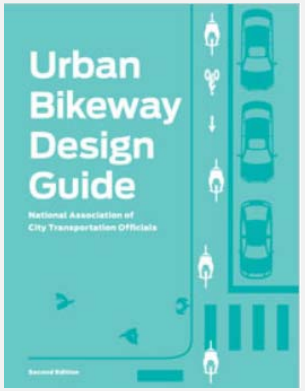
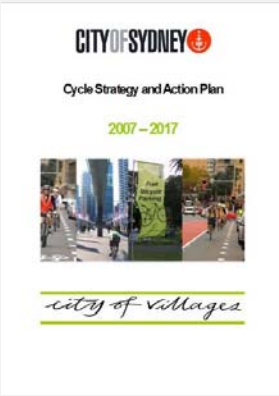




Movement and Place





Images source: NACTO http://nacto.org

Pedestrians Some important considerations

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Issues

- Collisions in CBD
- Collisions in high pedestrian activity areas
- Spatially random nature of crashes along arterials
- Intoxication still a significant issue

Treatments

- Lower speed limits
- Vertical deflection
- Dwell on red

Strategically – Long Term

- Movement and Place Framework

Source: http://dpti.sa.gov.au/newconnections/news/?a=145001

Pedestrians Safe System treatments

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Hierarchy	Treatment	Influence (E = exposure L = likelihood S = severity)
Safe System options ('primary' or 'transformational' treatments)	• Separation (footpath) • Separation (crossing point) • Very low speed environment, especially at intersections or crossing points.	E L L, S
Supporting treatments (compatible with future implementation of Safe System options)	• Reduce speed environment/speed limit • Pedestrian refuge • Reduce traffic volume.	L, S L E, L
Supporting treatments (does not affect future implementation of Safe System options)	• Pedestrian signals • Skid resistance improvement • Improved sight distance to pedestrians • Improved lighting • Rest-on-red signals.	L L L L L, S
Other considerations	• Speed enforcement.	L, S

Source: *Safe System Assessment framework,* Austroads 2016

Cyclists Safe System approach

“Mix traffic where speeds are low
Separate traffic where speeds are too high
And introduce targeted speed reduction where pedestrians and cyclists meet motorized traffic flows”

– Dutch Advancing Sustainable Safety

Motorcyclists Safe System treatments

Austroads

Hierarchy	Treatment	Influence (E = exposure L = likelihood S = severity)
Safe System options ('primary' or 'transformational' treatments)	• Separate motorcycle lane (e.g. on freeways).	E
Supporting treatments (compatible with future implementation of Safe System options)	• Shared motorcycle/bus/taxi lane (e.g. on freeways).	L
Supporting treatments (does not affect future implementation of Safe System options)	• Consistent design along the route (i.e. no out-of-context curves) • Consistent delineation for route • Skid resistance improvement • Motorcycle-friendly barrier systems.	L L L S
Other considerations	• Speed enforcement • Enforcement of other regulations.	L, S L

Source: Austroads 2016a

Motorcyclists : barrier protection ?

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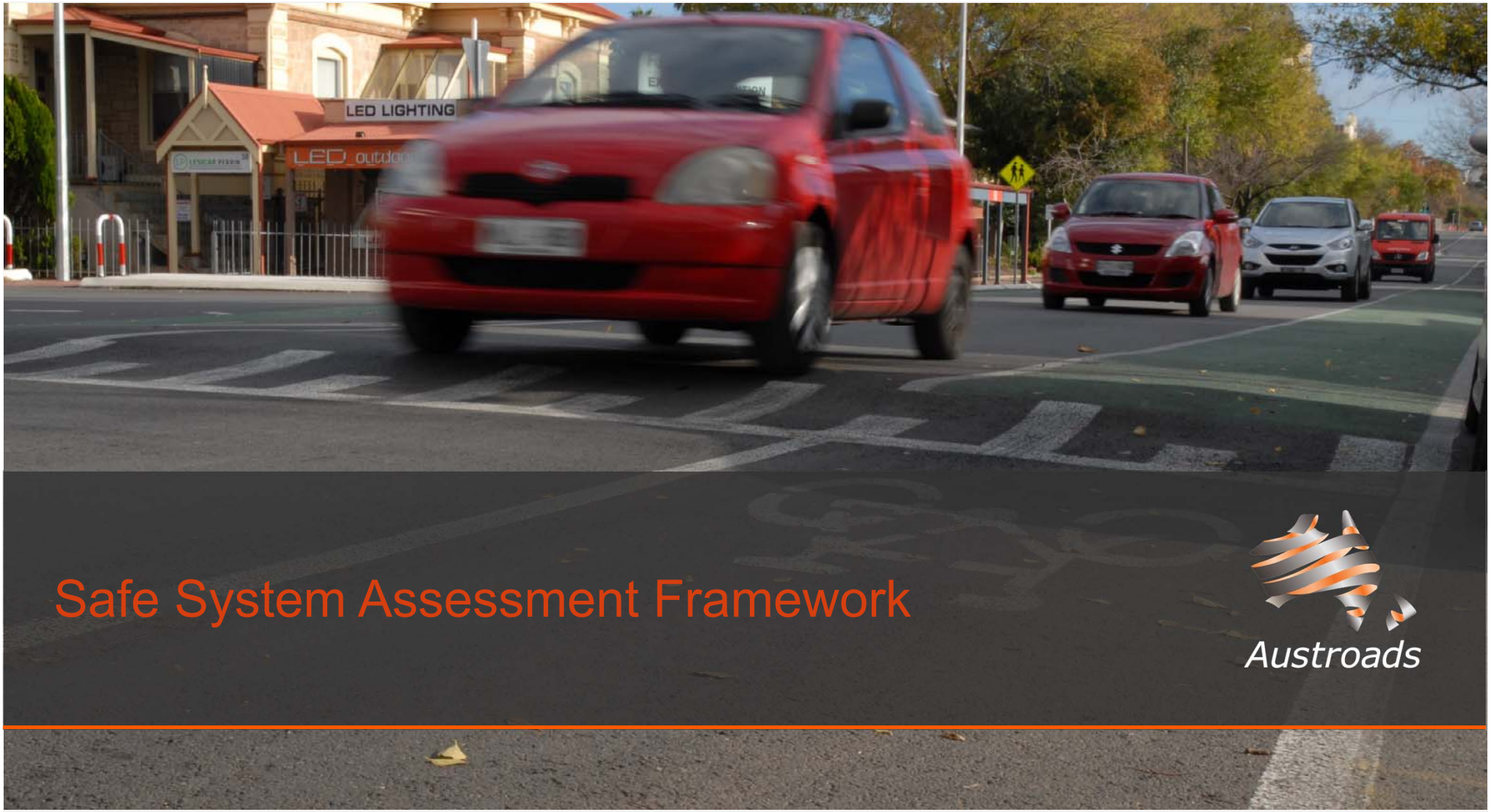
- Half of all barrier collisions occur with motorcyclist in sliding posture
- Severe injuries can occur at 30 km/h + impacts with barrier post (Bambach and Grzebieta 2015)
- Barriers that are more forgiving are evolving but not Safe System

Source: Dua and Sapkota 2012



Safe System Assessment Framework

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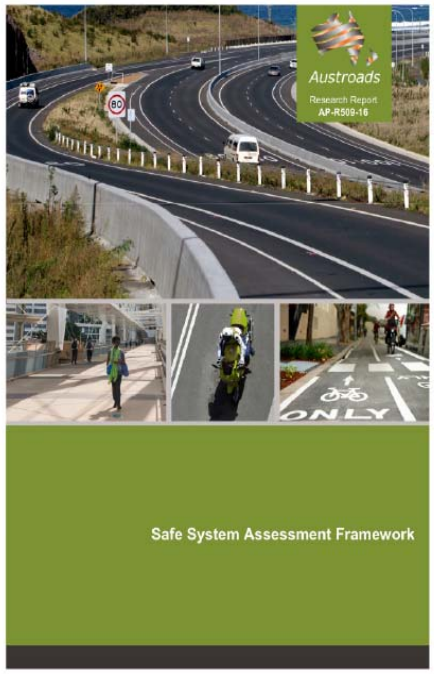
Safe System Assessment Framework



	Run-off-road	Head-on	Intersection	Other	Pedestrian	Cyclist	Motorcyclist
Exposure	AADT; length of road segment	AADT; length of road segment	AADT for each approach; intersection size	AADT; length of road segment	AADT; pedestrian numbers; crossing width; length of road segment	AADT; cyclist numbers; pedestrians	AADT; motorcycle numbers; length of road segment
Likelihood	Speed; geometry; shoulders; barriers; hazard offset; guidance and delineation	Geometry; separation; guidance and delineation; speed	Type of control; speed; design, visibility; conflict points	Speed; sight distance; number of lanes; surface friction	Design of facilities; separation; number of conflicting directions; speed	Design of facilities; separation; speed	Design of facilities; separation; speed
Severity	Speed; roadside features and design (e.g. flexible barriers)	Speed	Impact angles; speed	Speed	Speed	Speed	Speed

New Zealand example before and after review

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Table 4.3: Safe System matrix for Safe Roads and Roadsides and Safe Speeds

	ROR	HO	INT	OTHER	PED	CYC	M/C	
Exposure	3/4	3/4	3/4	3/4	1/4	2/4	3/4	
Likelihood	3/4	3/4	4/4	2/4	0/4	1/4	2/4	
Severity	3/4	4/4	4/4	2/4	4/4	4/4	4/4	
Product	27/64	36/64	48/64	12/64	0/64	8/64	24/64	159/448

Table 4.3: Safe System matrix for Safe Roads and Roadsides and Safe Speeds

	ROR	HO	INT	OTHER	PED	CYC	M/C	
Exposure	3/4	3/4	3/4	3/4	1/4	2/4	3/4	
Likelihood	3/4	1/4	2/4	1/4	9/4	2/4	2/4	
Severity	2/4	1/4	1/4	1/4	2/4	1/4	1/4	
Product	12/64	3/64	6/64	3/64	0/64	4/64	6/64	34/448

Change in scores across 14 projects in Victoria, Australia

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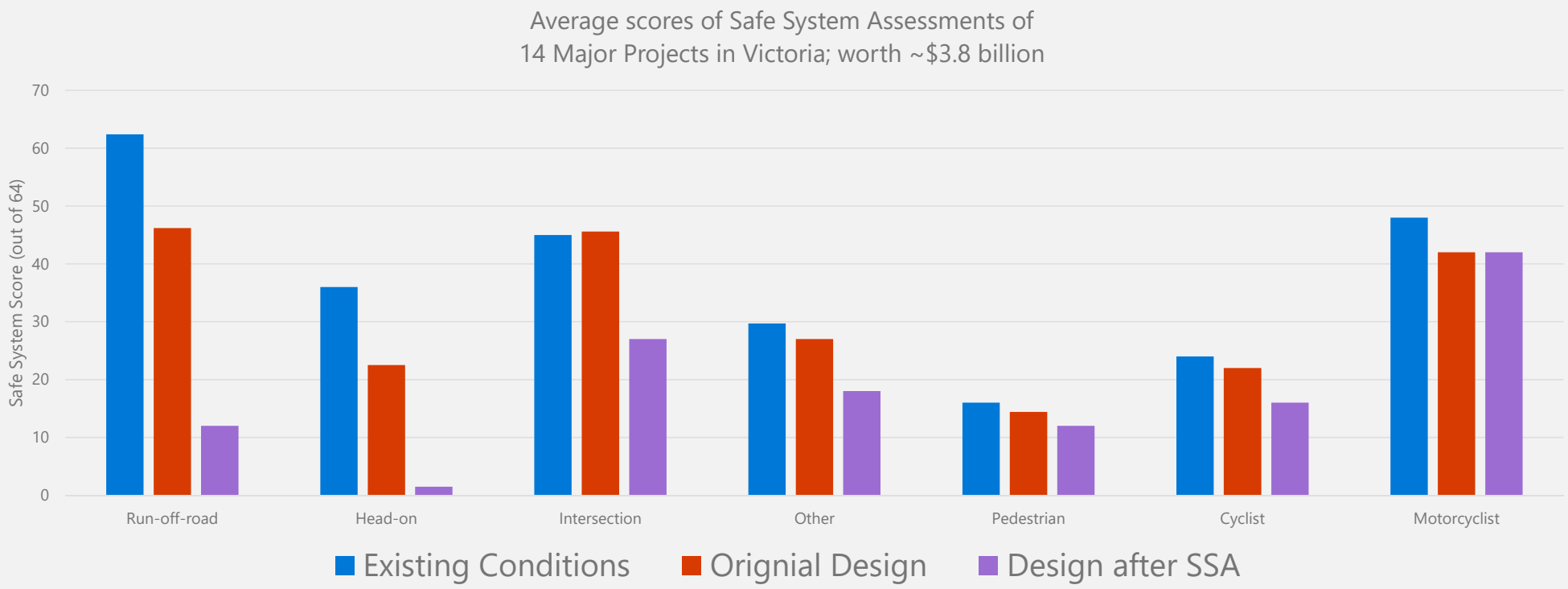

Projects Costs increased from 0% to 7%

Thank you for participating