

Left turn treatments at signalised intersections

Safety review

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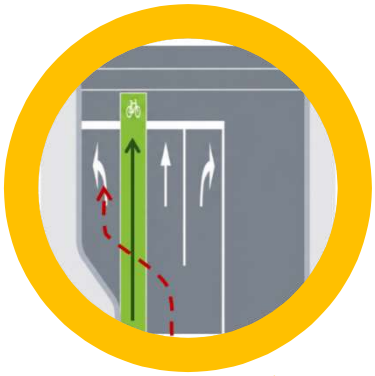


The secret title of this paper is:



Two quite polarised camps re SLs
NACTO recs: "*remove slip lanes where possible*" to **achieve** "*more compact intersections*" **expected** to "reduce ped exposure…".
Why wouldn't we want that? But, in S&G:
Well-designed slip lanes… by separating conflict points and reducing exposure on Xwalks
and reduce ped delay -priority Xing across SL, makes the signalised area more **compact -** reduce overall int cycle time.
We'll step through the safety research…

Treatments considered

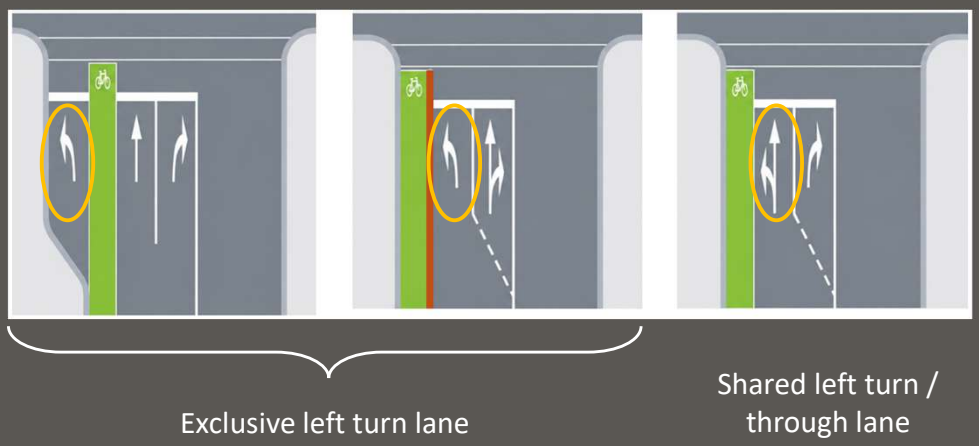


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We haven't done any new research, we've just tried to compile and compare some of the existing research.
Focus on safety, not urban design.
Two main groups...

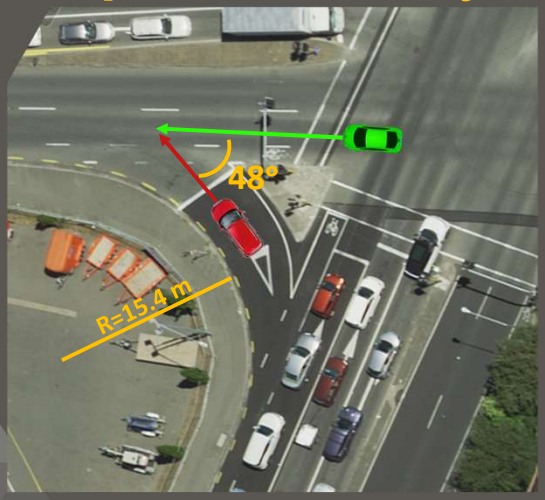
Left turns within the signalised intersection

- "Conventional left turns"

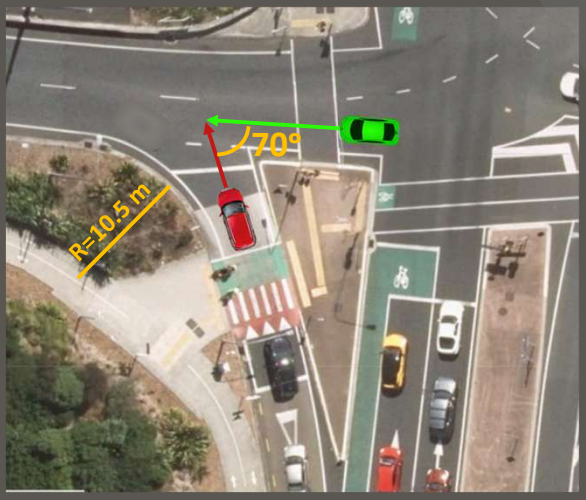


First group: LT within sig int. "Conventional left turns".
Two lane designations: lane exclusively for LTers, vs lane where LTers share with through traffic.
Obvs depends on space available, volumes etc.
Will see later: big consideration is how to manage conflict between LT drivers and through cyclists.

Slip lanes – entry angle



Low entry angle (<70°)
Radius > 15 m

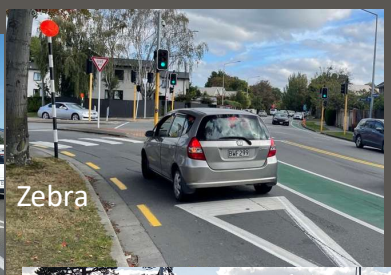


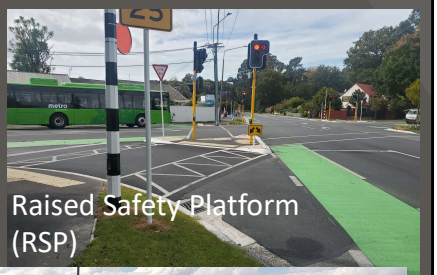
High entry angle (≥70°)
Radius 10—15 m

Next group: slip lanes
Focused on more compact urban intersections where, if a slip lane is provided, traffic doesn't have a dedicated departure lane.
Big distinction is the entry angle.
If angle between SL driver an cross traffic is low: SL driver going faster, looking well over shoulder, not going to see peds coming from their left.
HEA: slower speeds due to cornering geometry.
Drivers don't have to look as far over their shoulders towards approaching traffic – more likely to see peds from their left

Slip lanes – pedestrian crossing provisions



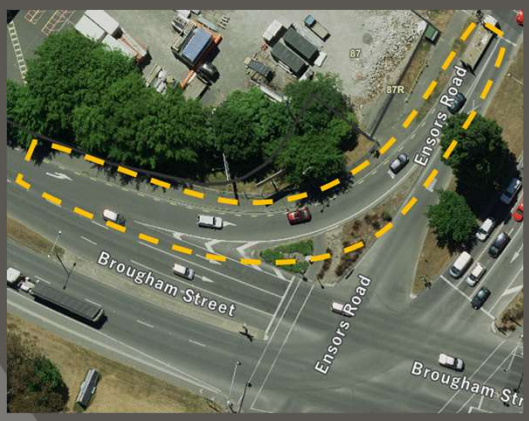




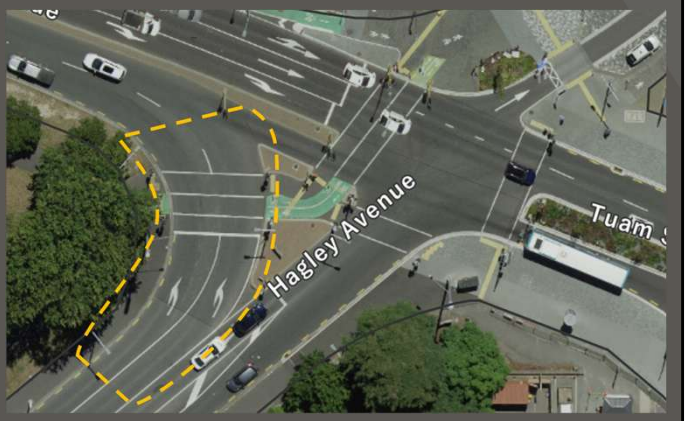


Another impt consideration:

Not our focus



Free-flow slip lanes
(conflict-free departure)



"Signalised" slip lanes
(conflict-free phasing)

Often covered in the literature.
Free-flow: no conflict on departure, merging / weaving later in mid block
Sig SLs: SL geometry, conflict-free phasing.
Although signalised slip lanes may be preferred / necessary for pedestrian safety.

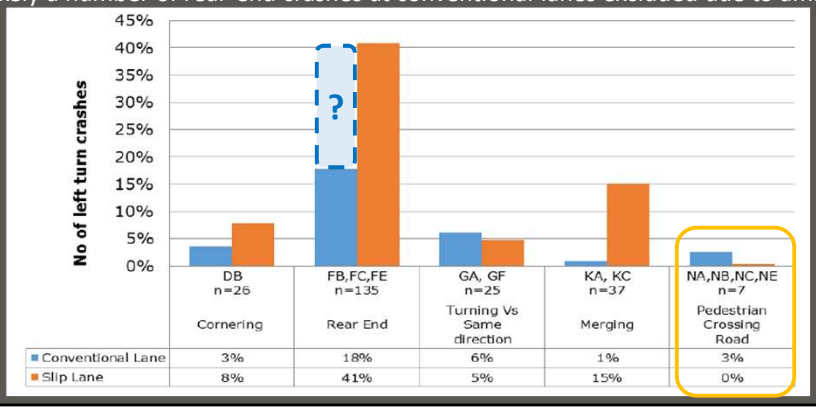
Safety performance



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General safety performance

- Sharobim (2016):
  - All left turn crashes, 1,818 sites, 1 year:
  - Slip lanes = 41% of treatments but 69% of crashes
    - Likely a number of rear-end crashes at conventional lanes excluded due to ambiguity



Romany gave a useful overview of crashes involving left turners in Auckland. First looking at all signalised intersections for one year.
SLs comprise 41% of LT treatments on the network, but account for 69% of crashes
Many rear-end crashes at conventional lanes could not be confidently assigned to a left-turn lane from the crash report information and were therefore excluded, whereas slip lane rear-ends easier to identify.
Note ped crashes very low proportion of total, and more at conventional lanes

General safety performance – treatments

- Sharobim (2016):
  - All left turn crashes, 267 sites, 5 years, accounting for traffic exposure:
  - "comparable safety performance"
  - Without accounting for slip lane angle (other sources show HEA safer than LEA)

Left Turn Treatment Type		Exposure per entering vehicles X 10^8 X 5Yrs (100 MEV)		Left turn crash types		Left turn crash rate (5Yrs)
		approach Volume	% of approach Volume	No. of left turn crashes	% of left turn crashes	
Slip Lane	Signalised	3.0	7%	19	14%	6.42
	Free Flow	2.5	6%	3	2%	1.19
	Giveway No Pedestrian Marking	10.0	23%	27	19%	2.70
	Zebra Crossing	7.2	17%	23	16%	3.18
	Raised Zebra Crossing	0.0	0%	0	0%	0.00
	Slip Lane Sub Total	**22.7**	52%	**72**	**51%**	**3.17**
Conventional Lane	Exclusive Lane	5.2	12%	29	21%	5.53
	Shared lane	15.8	36%	39	28%	2.46
	Conventional Lane Sub Total	**21.1**	48%	**68**	**49%**	**3.23**
	Overall	**43.8**	**100%**	**140**	**100%**	**3.20**

In a more detailed analysis of a subset, accounting for traffic exposure,
Found "comparable safety performance" crash rate of 3.17 vs 3.20 crashes per million entering vehicles per LT treatment approach in 5 years.
With some notable differences between treatment types.
Interesting because he didn't subdivide the slip lanes according to entry angle.
We have cited other studies and guides in the paper that show increasing the entry angle improves safety performance.

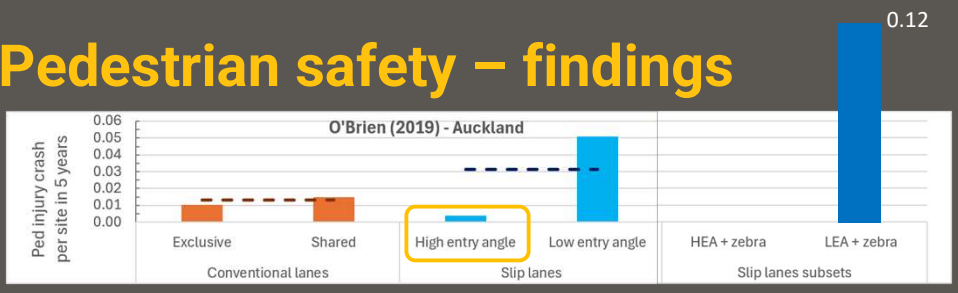
Pedestrian safety – key sources

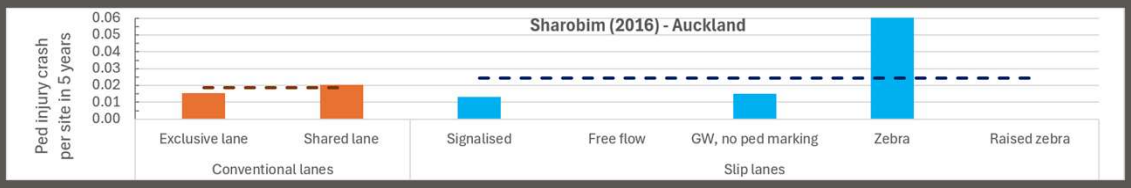
Study	Location	# left turn approaches	Analysis period
Andrew O'Brien (2019)	Auckland	1,696	2013–2017
Romany Sharobim (2016)	Auckland	1,818	2010–2014
Mark O'Brien *et al*. (2010 & 2012)	Melbourne	6,978	2004–2008

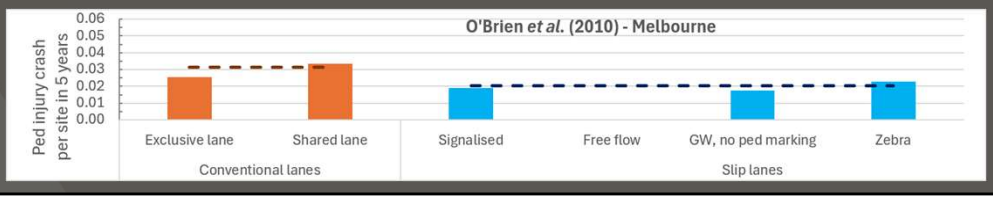
- Included free-flow and signalised slip lanes
- None accounted for pedestrian exposure
  - Pedestrian crossings more likely provided where there is higher crossing demand
- Jaglal and Wilson (2012, Auckland): *where a treatment compromises intersection efficiency, users may respond by making risky or non-compliant choices*

Ped vs left turner crashes relatively low, but important - more likely to result in higher severity.
3 key studies. All had slightly different ways of slicing and dicing the data.
Included FF & sig SLs
No ped exposure – probably make high demand sites look worse.
One other study – pertinent comment: J&W: If we take a slip lane away to make things safer, might actually make it less safe.

Pedestrian safety – findings







O'B Melbourne: SLs on av. safer for peds than CLs.
Sharobim Akld: SLs slightly more dangerous. Something going on for Auckland vs Melbourne (geometry, level of ped protection at signals, matching ped provision to demand?). Note high instance at zebra crossings (high ped vols)
O'Brien 2019 Auckland: also found slip lanes to be more dangerous, and strangely with a bigger margin (changes over time, analysis methods?). But accounted for entry angle and HEA safest overall.
Further – just looking at SLs with zebra Xings: no crashes at HEA, LEA off the chart.

Pedestrian safety – further observations

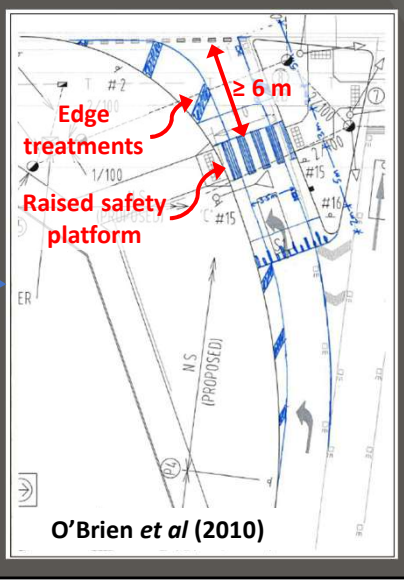
O'Brien *et al* (2010, Melbourne)

Each HEA slip lane: ≥ 1 x



O'Brien (2019, Auckland)

Only **one** pedestrian crash across **265** HEA slip lanes.



O'B 2010 vs O'B 2019: exposure, location, time? – Safe Systems thinking?
Very few raised slip lane crossings in any of the three studies.

O'Brien (2010): ways to **focus drivers on pedestrians**:

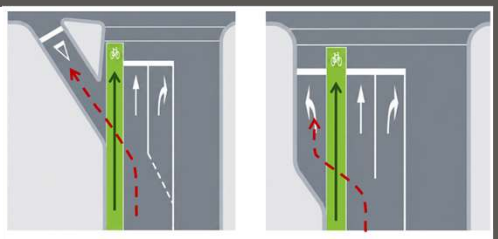
- Crossing point set back ≥ 6 m from limit line
- Edge treatments – because geometry designed for HVs, want to influence angle of light vehicles
- Raised platform crossing – speed, focus on bump rather than gap

Cyclist safety

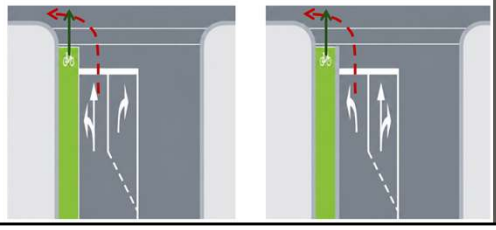
- Safer to address conflict on the approach vs through the intersection
  - Easier to do with slip lanes and exclusive left turn lanes

Conflict on approach to intersection:

~4x safer



Conflict through intersection:



- Risks for cyclists across a slip lane exit
  - HEA and raised crossings help mitigate this



Less research about this.

Conclusions

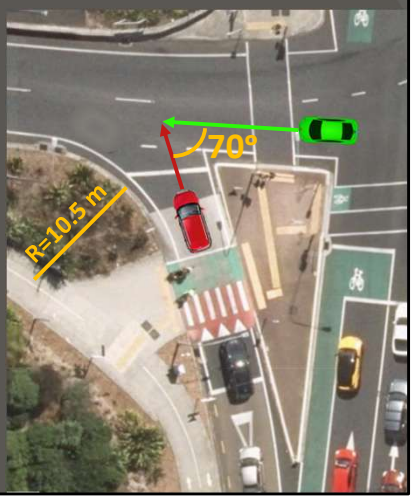


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Overall conclusion:

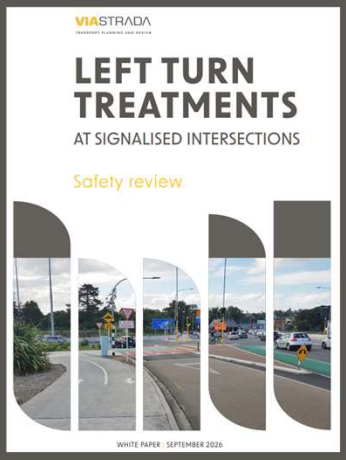
Not all slip lanes are created equal

- Slip lanes and conventional signalised left turns have *comparable* general safety
- High entry angle slip lanes are the safest for pedestrians
  - Raised crossings and other treatments can further improve this
- Further research:
  - Account for pedestrian exposure
  - Study cyclist safety



Shown that when comparing SLs and CLs: comparable safety across all crashes.
But, within SL category – HEA much safer, esp for peds.
Still work to be done in understanding this:

Find out more



https://viastrada.nz/publication/left-turn-treatments-signalised-intersections

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