Classifying Horizontal Curves and Crash Risks

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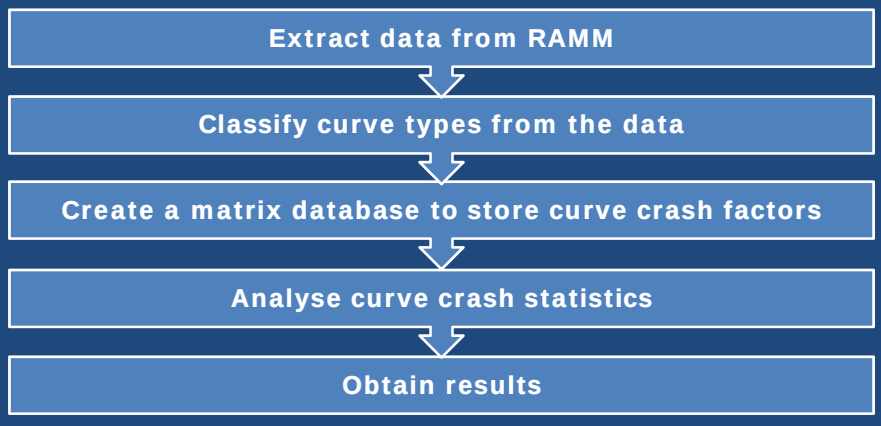
Introduction

- Poor geometric design leads to more crashes
- Over half of crashes on the State Highway network are on curves
- Current prediction models do not consider how the radius of a curve changes

Objectives

- To develop an automated computer method to identify curve types based on curvature values.
- Analyse the difference in crash rates between curve types.
- Analyse crash rate relationships using predictor variables, such as Average Daily Traffic and Approach Speed.

Methodology



Data Collection

- WDM conduct high-speed surveys of the state highway network.
- This data is processed and sent to NZTA where it is uploaded into the RAMM database.

Regions of Research

Segment Classification

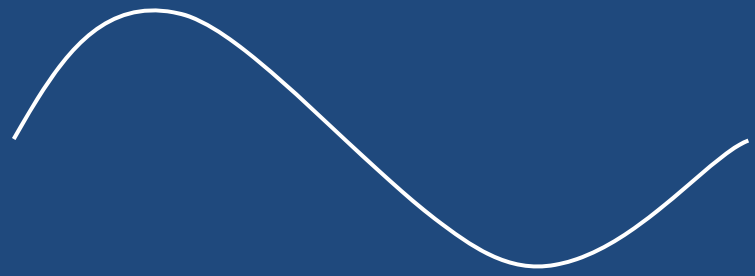
- Straight radius > 2000m
- Transition radius < 2000m
  dr/dx > 10m/segment
- Circle radius < 2000m
  dr/dx < 10m/segment

Curve Types

- Circle – A curve with constant radius throughout.

Curve Types

- Reverse – An event with more than one curve in opposite directions.



Curve Types

- Broken Back – An event with more than one curve, but all in the same direction.

Curve Types

- Transition – A curve which starts and ends on a spiral section with a circle section.

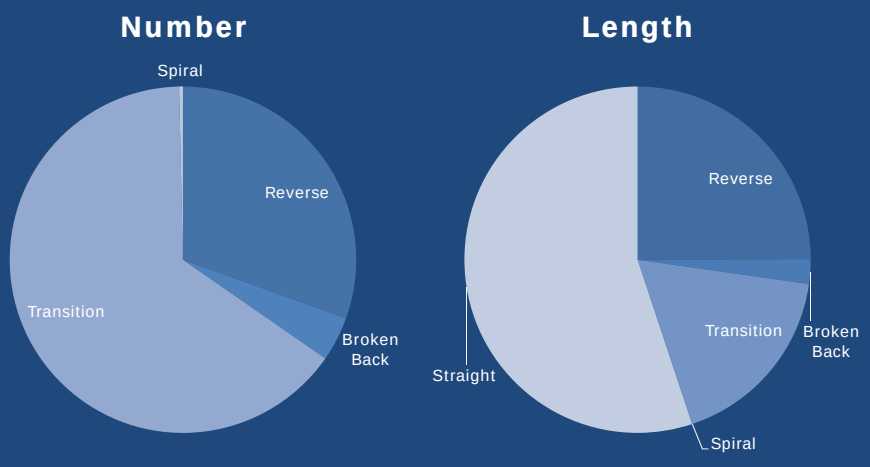
Curve Types

- Spiral – A curve with no constant radius.

Matrix Inputs

- Geometry
- Crash data
- Carriageway data
- Approach Speed data (courtesy of Fergus Tate, NZTA)

SummaryStats



Data Verification

- How do we know our automated process is correct?
- Are the horizontal curves our code is detecting correct?

Data Verification

GPS Coordinates

6367820.6	2827620.9
6367824.2	2827630.4
6367827.7	2827639.6
6367830.7	2827648.2
6367834.2	2827657.9
6367837.6	2827667.8
6367840.6	2827677.2
6367843	2827685.5
6367845.7	2827695.7
6367848	2827705.5
6367850.1	2827715.9
6367851.8	2827725.4
6367852.8	2827735.1
6367853.7	2827745
6367854.1	2827753.9
6367854.3	2827764.1
6367854.2	2827775.1
6367853.8	2827784.9
6367853.2	2827793.8
6367852.2	2827803.6
6367851	2827813.3
6367849.4	2827823
6367847.4	2827833.4
6367845.2	2827843.1
6367842.7	2827852.6
6367839.9	2827861.6
6367836.8	2827870.7
6367833.4	2827879.9
6367829.8	2827888.8
6367825.7	2827898.2
6367821.6	2827907.1
6367817.1	2827916.1
6367812.6	2827924.8
6367807.8	2827933.9
6367802.9	2827942.7
6367798.1	2827951.2

Algorithm

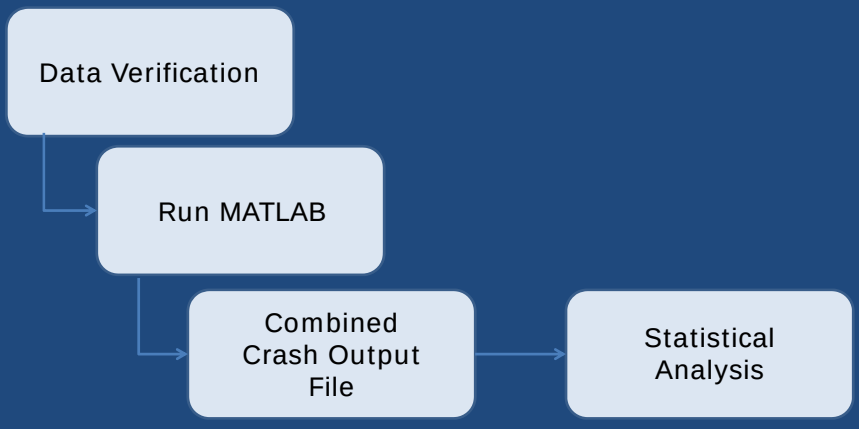
CURVE	0	CURVE	1	2	1	1	LEFT	2			1
CURVE	0	CURVE	2	2	1	2	LEFT	2			1
CURVE	0	CURVE	3	2	1	3	LEFT	2			1
CURVE	0	CURVE	4	2	1	4	LEFT	2			1
CURVE	0	CURVE	5	2	1	5	LEFT	2			1
CURVE	0	CURVE	6	2	1	6	LEFT	2			1
CURVE	0	CURVE	7	2	1	7	LEFT	2			1
CURVE	0	CURVE	8	2	1	8	LEFT	2			1
CURVE	0	CURVE	9	2	1	9	LEFT	2			1
CURVE	0	CURVE	10	2	1	10	LEFT	2			1
CURVE	0	CURVE	11	2	1	11	LEFT	2			1
CURVE	0	CURVE	12	2	1	12	LEFT	2			1
CURVE	0	CURVE	13	2	1	13	LEFT	2			1
CURVE	0	CURVE	14	2	1	14	LEFT	2			1
CURVE	0	CURVE	15	2	1	15	LEFT	2			1
CURVE	0	CURVE	16	2	1	16	LEFT	2			1
CURVE	0	CURVE	17	2	1	17	LEFT	2			1
CURVE	0	CURVE	18	2	1	18	LEFT	2			1
CURVE	0	CURVE	19	2	1	19	LEFT	2			1
CURVE	0	CURVE	20	2	1	20	LEFT	2			1
CURVE	0	CURVE	21	2	1	21	LEFT	2			1
CURVE	0	CURVE	22	2	1	22	LEFT	2			1
CURVE	0	CURVE	23	2	1	23	LEFT	2			1
CURVE	0	CURVE	24	2	1	24	LEFT	2			1
CURVE	0	CURVE	25	2	1	25	LEFT	2			1
CURVE	0	CURVE	26	2	1	26	LEFT	2			1
CURVE	0	CURVE	27	2	1	27	LEFT	2			1
CURVE	0	CURVE	28	2	1	28	LEFT	2			1
CURVE	0	CURVE	29	2	1	29	LEFT	2			1
CURVE	0	CURVE	30	2	1	30	LEFT	2			1
CURVE	0	CURVE	31	2	1	31	LEFT	2			1
CURVE	0	CURVE	32	2	1	32	LEFT	2			1
CURVE	0	CURVE	33	2	1	33	LEFT	2			1
CURVE	0	CURVE	34	2	1	34	LEFT	2			1
CURVE	0	CURVE	35	2	1	35	LEFT	2			1
CURVE	0	CURVE	36	2	Not 2 Circle	36	LEFT	2		Not Broken	1 Transition

Start of Transition Curve

End of Transition Curve

Data Verification

Data Verification

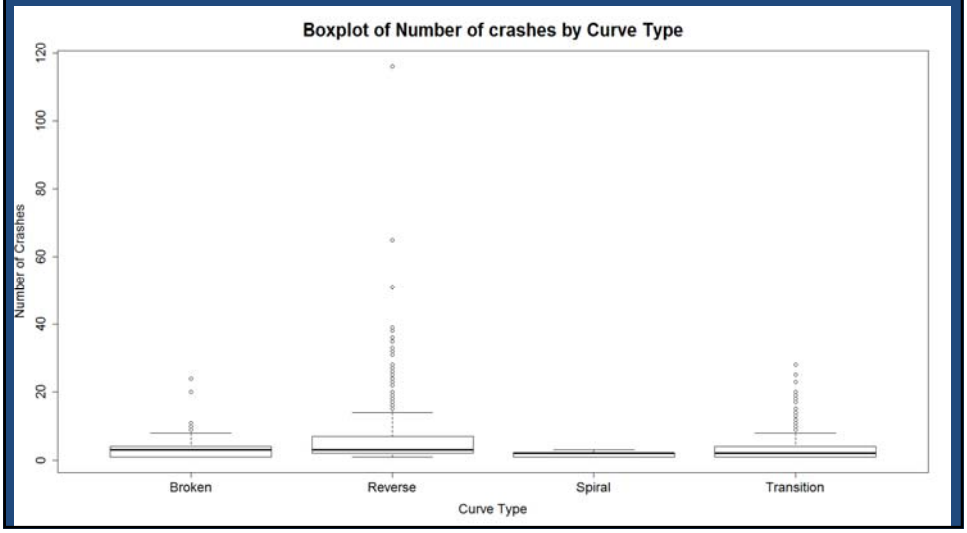


Statistical Analysis

Preliminary preparation before statistical analysis

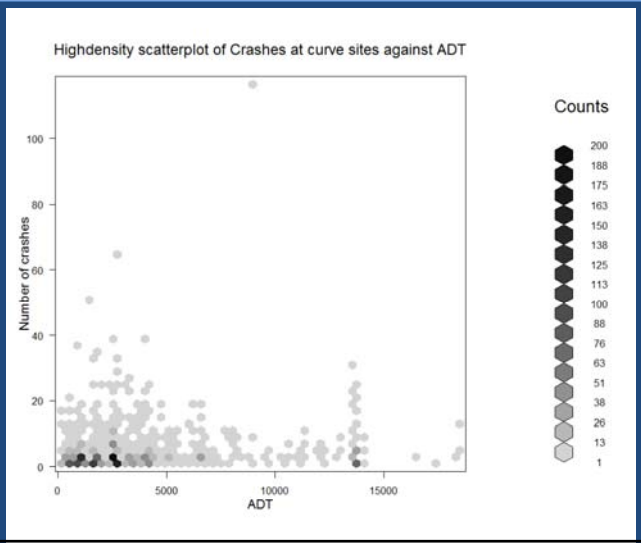
- **Remove urban sections**
- **Filtered out curves with ZERO crashes on them**
  - Too many curve with zero crashes can skew the data.
- **Filtered out intersection crashes**
  - Intersections can be located on horizontal curves.
  - Only want to observe crashes due to horizontal curves, not intersection crashes.

Statistical Analysis

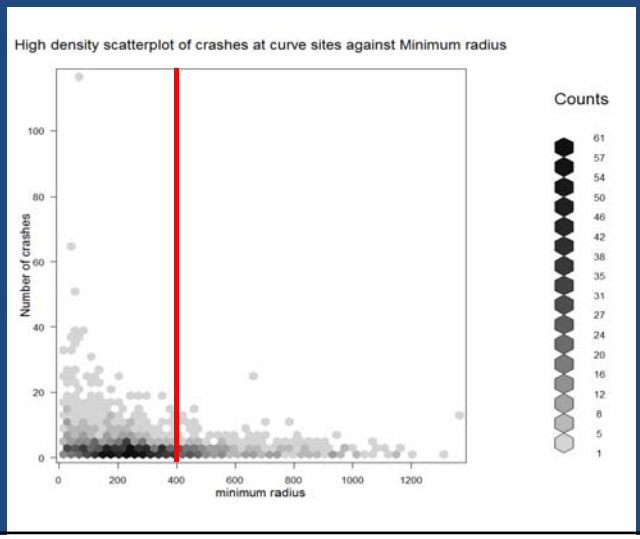


Statistical Analysis

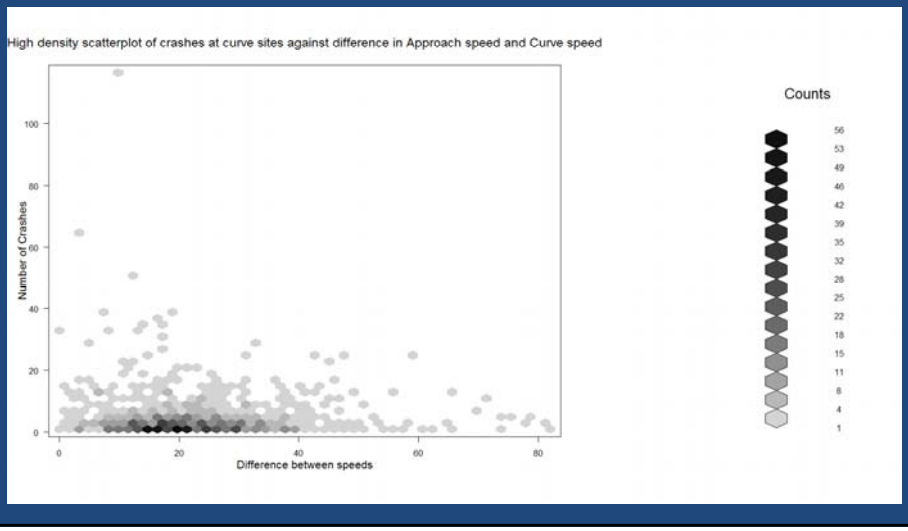
Statistical Analysis



Statistical Analysis



Statistical Analysis



Conclusion

- Most curves are transition type curves. Curves make up about 45% of road network.
- No difference between crashes and type of curve.
- As minimum radius decreases below 400m, more crashes occur.
- Crashes are statistically rare, random, multifactor events.

Future Research

- Future research can look at other regions to notice if patterns in curve to exist.
- Further work could include looking at differentiating between the severity of crashes.

Acknowledgements

- Dr Doug Wilson, UoA
- Dr Tam Larkin, UoA
- Fergus Tate, NZTA
- Darren Newland, WDM
- Don McKenzie, TDG

Questions?