

Calibration of Overseas Highway Crash Prediction Models for New Zealand

- A Case Study With IHSDM

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Summary

Crash prediction models (CPMs) are an increasing feature of rural highway design practice internationally. A significant related development was the *Interactive Highway Safety Design Model* (IHSDM) in the US. However it would be difficult for every country to develop similar design tools with the same degree of complexity and research.

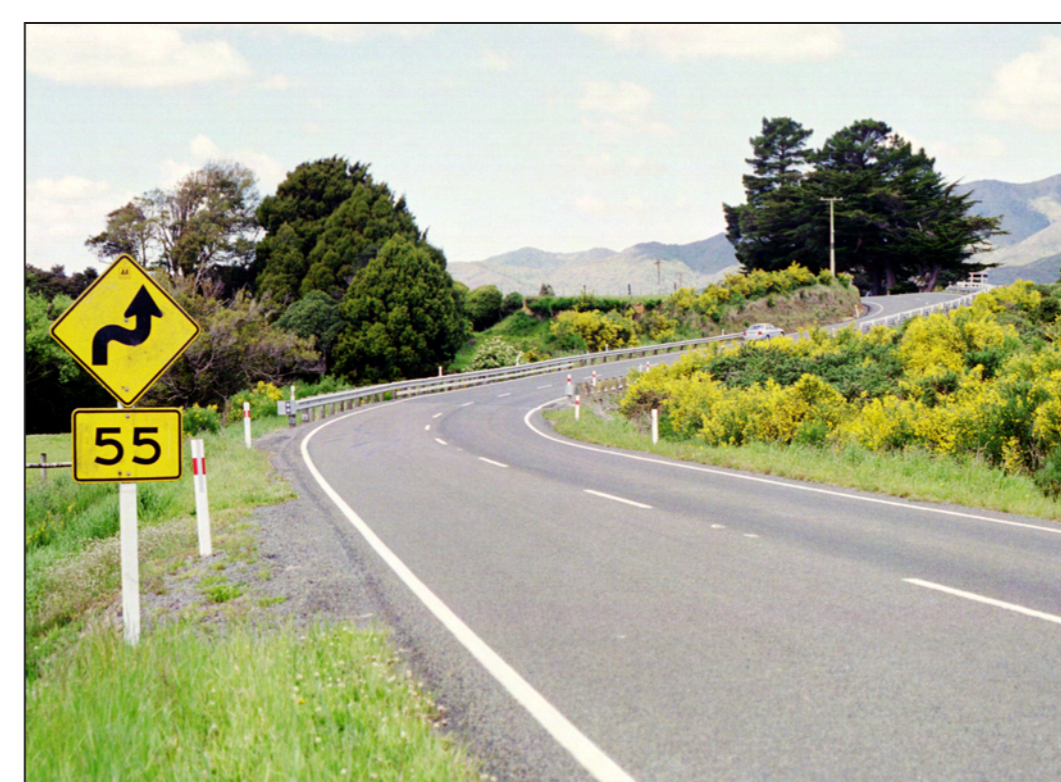
Research has recently been exploring ways to assess the safety performance of rural highways in New Zealand. IHSDM was identified as worthy of further investigation, and a number of tasks were undertaken to adapt it for use in NZ. These included developing suitable data importing routines and calibrating IHSDM's CPM to match NZ crash patterns.

A series of validation tests assessed IHSDM's effectiveness in predicting the relative safety of NZ rural roads. These included a "before and after" crash comparison of a major highway realignment, and checks of crash numbers along highway lengths in varying terrain. The investigations showed that IHSDM is a promising tool for safety and operational assessment of highway alignments (both existing and proposed) in NZ. However, IHSDM's current lack of consideration for bridges and inconsistent road elements limit the ability of its CPM to assess sub-standard existing routes with as much accuracy as well-designed newer alignments.

Study Aims

Research has recently been completed to explore ways to assess the safety performance of (predominantly two-lane) rural highways in NZ. As part of this, IHSDM was identified as worthy of further investigation for use in NZ. The main objectives of the research were:

- To identify road and environmental factors affecting (non-intersection) crashes on rural roads in NZ, particularly at horizontal curves.
- To identify the tasks required to adapt IHSDM for use in NZ and to undertake the necessary adaptations.
- To assess the effectiveness of IHSDM in New Zealand for predicting the relative safety of a rural road alignment, by comparing it against local highway and crash data.



Typical NZ rural road

Interactive Highway Safety Design Model

- Developed by US Federal Highways Administration (FHWA) since ~1994
- Set of software tools for assessing safety impacts of geometric design decisions
- Initial development focused on two-lane rural highways (first public version 2003)



IHSDM therefore very applicable to the bulk of NZ's rural state highway network

Six linked analysis modules:

Crash Prediction Module (CPM)	Design Consistency Module (DCM)	Driver/Vehicle Module (DVM)	Intersection Diagnostic Review Module (IRM)	Policy Review Module (PRM)	Traffic Analysis Module (TAM)
Estimate the number and severity of crashes on specified roadway segments	Assess the extent to which a roadway design conforms to drivers' expectations (especially speed profiles)	Estimate drivers' speed and path choice along a roadway	Evaluate intersection design alternatives, and suggest countermeasures to safety problems	Verify compliance of designs with specified highway design policies and guidelines	Estimate the operational effects of designs under traffic flows, e.g. travel times, time spent following, vehicle interactions

- Also a built-in highway editor and import tools for major CAD/design software packages

Adaptation of IHSDM to NZ

Tasks to make IHSDM suitable for NZ use:

- Calibrate Crash Prediction Model with NZ data
- Develop NZ Design Policy file based on local agency standards and guidelines
- Develop importing routine for NZ highway geometry & crash data

State Highway data used for analysis

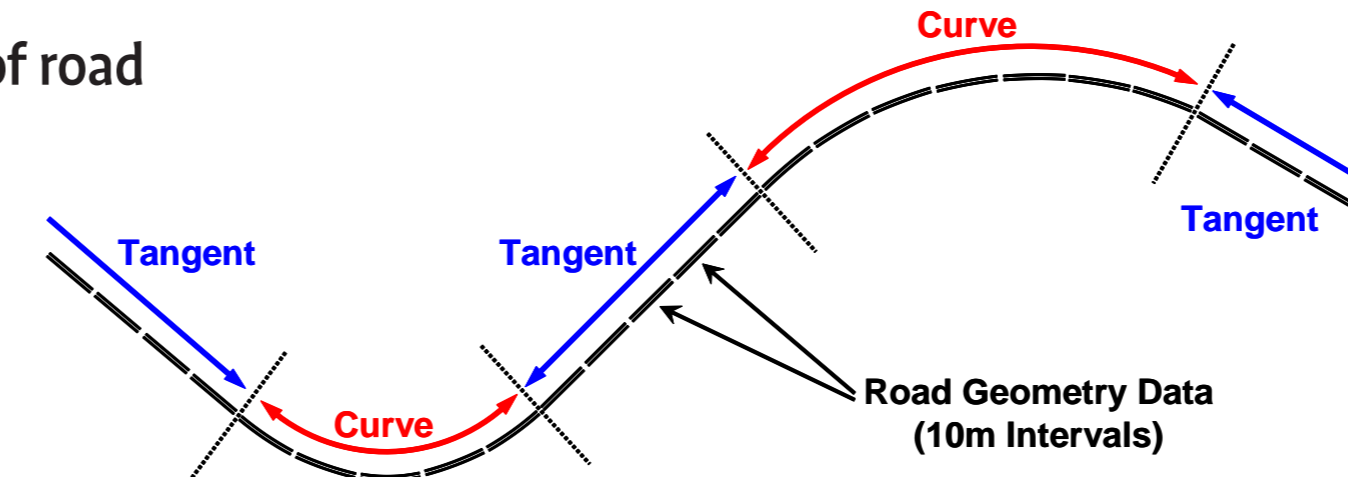
- Geometry data (radius, gradient)
- Crash data (CAS)
- Other RAMM data (AADT, cross-section, speed limits, etc)

Variable-length Elements generated from similar sections of road

Sample Road Geometry Data

Dirn	SH	RS	RP	Gradient	H2Rad	H2Curv	XFALL	Curve	AdvSpd
Incr	003	158	0.98	8.2	3735	0.3	-1.9	Right	83.9
Incr	003	158	0.99	8.2	14713	0.1	-1.4	Straight	84.1
Incr	003	158	1.00	8.2	-8627	-0.1	-1.2	Left	84.2
Incr	003	158	1.01	8.1	-8555	-0.2	-1.1	Left	84.5
Incr	003	158	1.02	8.0	11865	0.1	-1.3	Straight	84.9
Incr	003	158	1.03	7.9	-32019	0.0	-2.0	Straight	85.4
Incr	003	158	1.04	7.9	-7250	-0.1	-2.8	Left	85.6
Incr	003	158	1.05	7.9	4642	0.2	-2.8	Right	85.6
Incr	003	158	1.06	7.8	2891	0.3	-2.9	Right	85.8
Incr	003	158	1.07	7.7	1549	0.6	-2.7	Right	86.4
Incr	003	158	1.08	7.6	1075	0.9	-1.3	Right	87.0
Incr	003	158	1.09	7.6	810	1.2	0.1	Right	87.4

Generation of Road Geometry Elements



CPM Calibration Factors

Overall NZ Calibration Factors:

(Two levels of calibration detail available)

Crash Analysis Period	1996-2000	2002-2006
Number of Observed Crashes in NZ	18 052	20 805
Predicted No. of Crashes (IHSDM Level 1)	20 423.9	24 433.4
Level 1 Factor	0.884	0.851
Predicted No. of Crashes (IHSDM Level 2)	20 508.3	24 536.6
Level 2 Factor	0.880	0.848

Lower than US: Better safety record or just lower reporting rate?

- Simpler Level 1 Calibration process is sufficient

Sub-national Calibration Factors also calculated by

- Number of traffic lanes (2/3/4)
- Traffic Volume (AADT) categories
- Terrain (Flat/Rolling/Mountainous)
- Local Region

Few significant differences found; Results generally support using same NZ calibration factor for all situations

Validation Studies Undertaken

Check existing/proposed bridge alignments using DCM and CPM

Check crash estimates before and after 7km realignment in 2001

Calibrate by region and terrain, compare with actual 2000-02 crashes

SH1N Waipu - Wellsford (rolling)

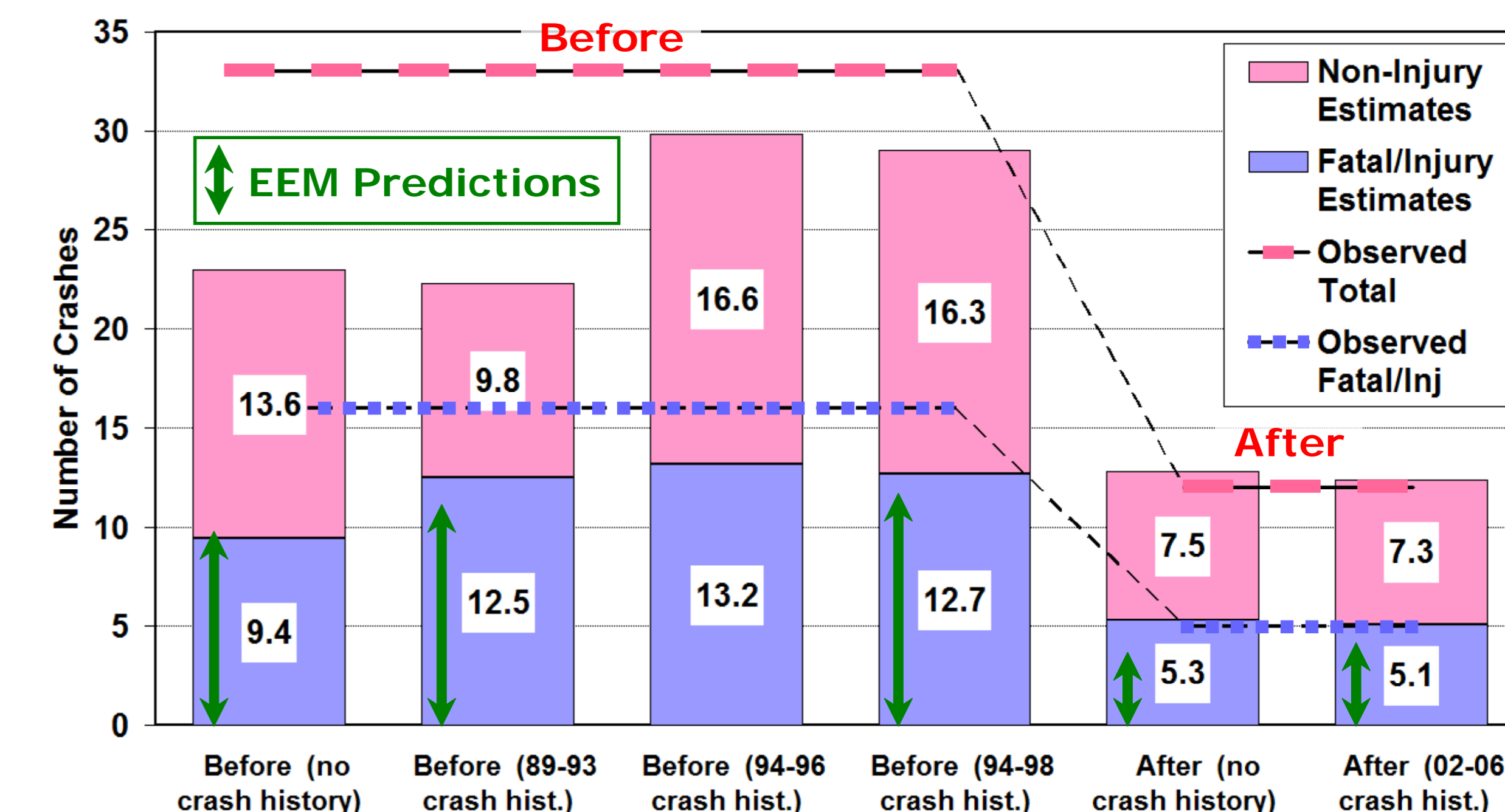
SH2 Rimutaka Saddle (mountainous)

SH1S Christchurch - Ashburton (flat)

SH1S Awatere Bridge

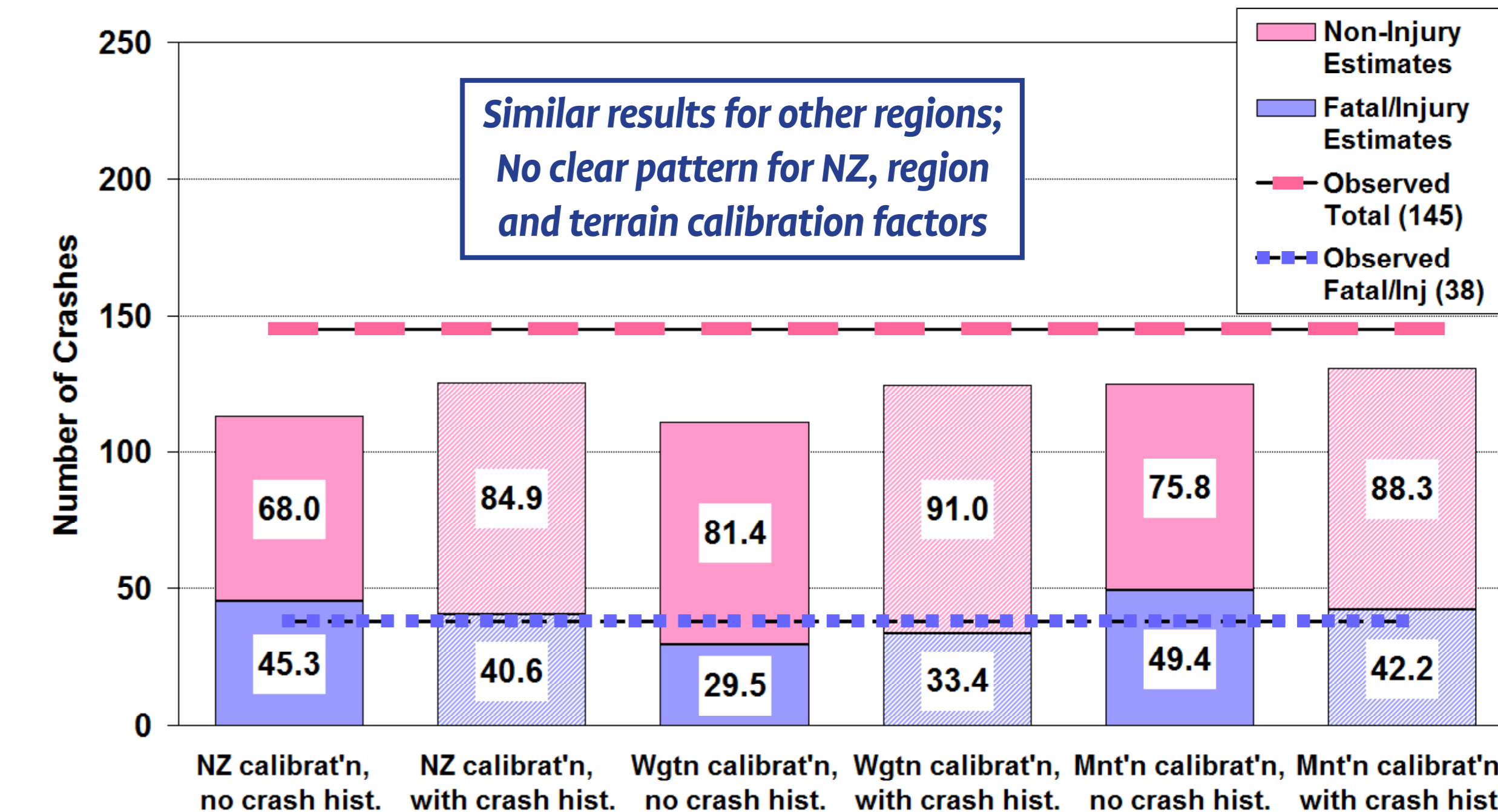
SH1S Hawkeswood-Siberia-Ferniehurst (HSF) Realignment

Results: CPM Predictions for SH1s HSF Site



While the new "after" alignment is well predicted by IHSDM, it is more conservative with the less consistent "before" alignment

Results: CPM Predictions for SH2 Rimutakas



Similar results for other regions; No clear pattern for NZ, region and terrain calibration factors

Key Conclusions & Recommendations

- IHSDM is a promising tool for safety and operational assessment of existing/proposed highway alignments in NZ.
- Crash history data is generally needed to obtain a reasonable level of precision in the CPM, particularly for sections with inconsistent or sub-standard design elements
- Crash history data appears to provide a better level of "local calibration" than attempting to derive specialised calibration parameters for each sub-region, and requires far less effort.
- Reported fatal/injury crash data provide a more consistent set to work with and to estimate crash numbers for.
- The level of detail applied to the specification of the road alignment is important for an accurate crash estimate in IHSDM, particularly the correct specification of the extreme attributes of sub-standard elements.
- The lack of consideration for bridges and inconsistent adjacent elements are notable omissions from IHSDM's CPM, and they can only be partly rectified by adjusting other attributes (such as lane/shoulder width).

Research Report for Details:

Koorey, G.F. (2009). *Incorporating Safety into Rural Highway Design*. PhD Thesis in Transportation Engineering, Department of Civil and Natural Resources Engineering, University of Canterbury, Christchurch, NZ. <http://hdl.handle.net/10092/3102>

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