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ICMPA9 • International Conference on Managing Pavement Assets

SWINBURNE UNIVERSITY OF TECHNOLOGY

Assessing the Impacts of Pavement Surface Condition on the Performance of Signalised Intersections

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TRB

U.S. Department of Transportation Federal Highway Administration

WORLD ROAD ASSOCIATION MONDIALE DE LA ROUTE 1909-2009

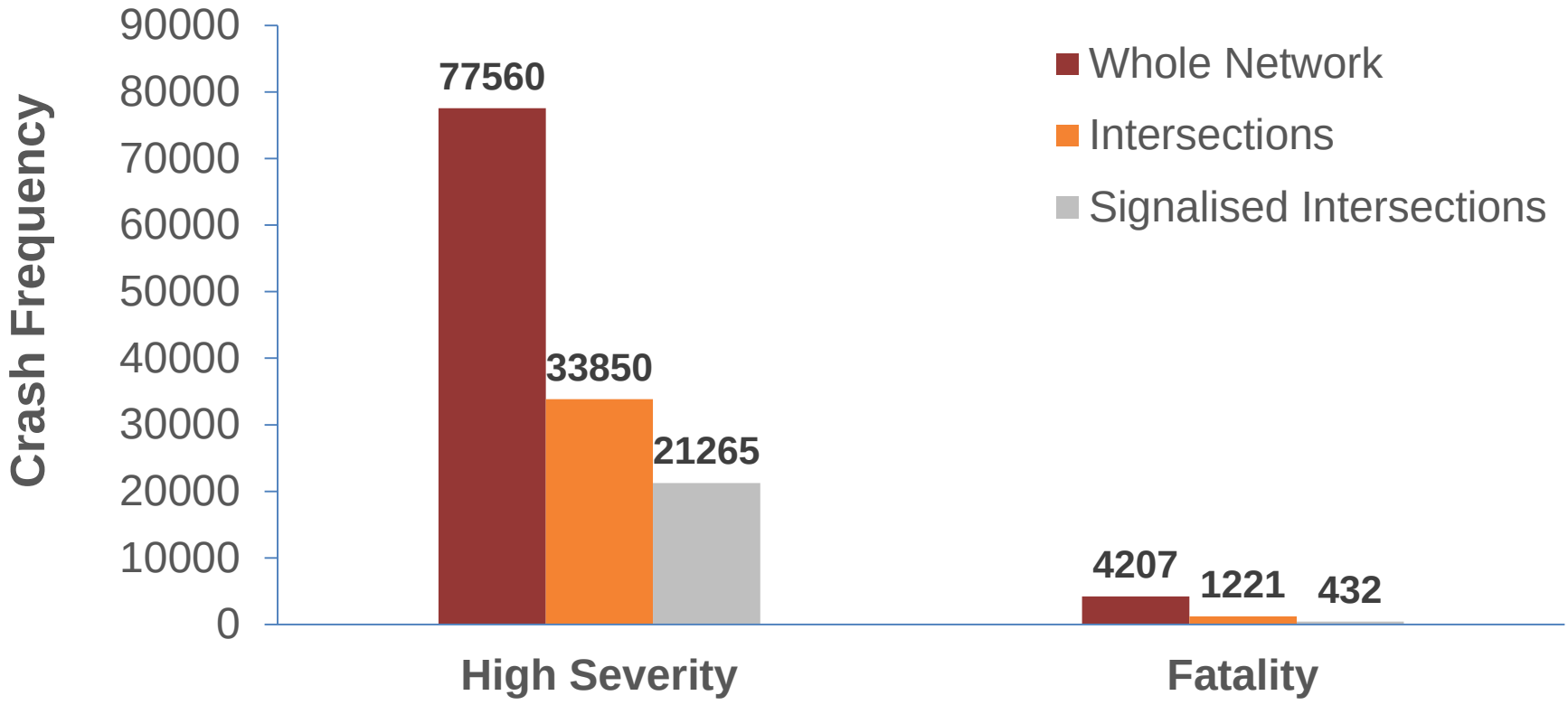
VDOT Virginia Department of Transportation

Outline

- Introduction
- Aim and Objectives of the Study
- Data Analysis and Results
- Statistical Analysis
- Conclusions

INTRODUCTION

High Severity and Fatality crash data for Melbourne/Australia over the years (2000 to 2013)



Study Aim

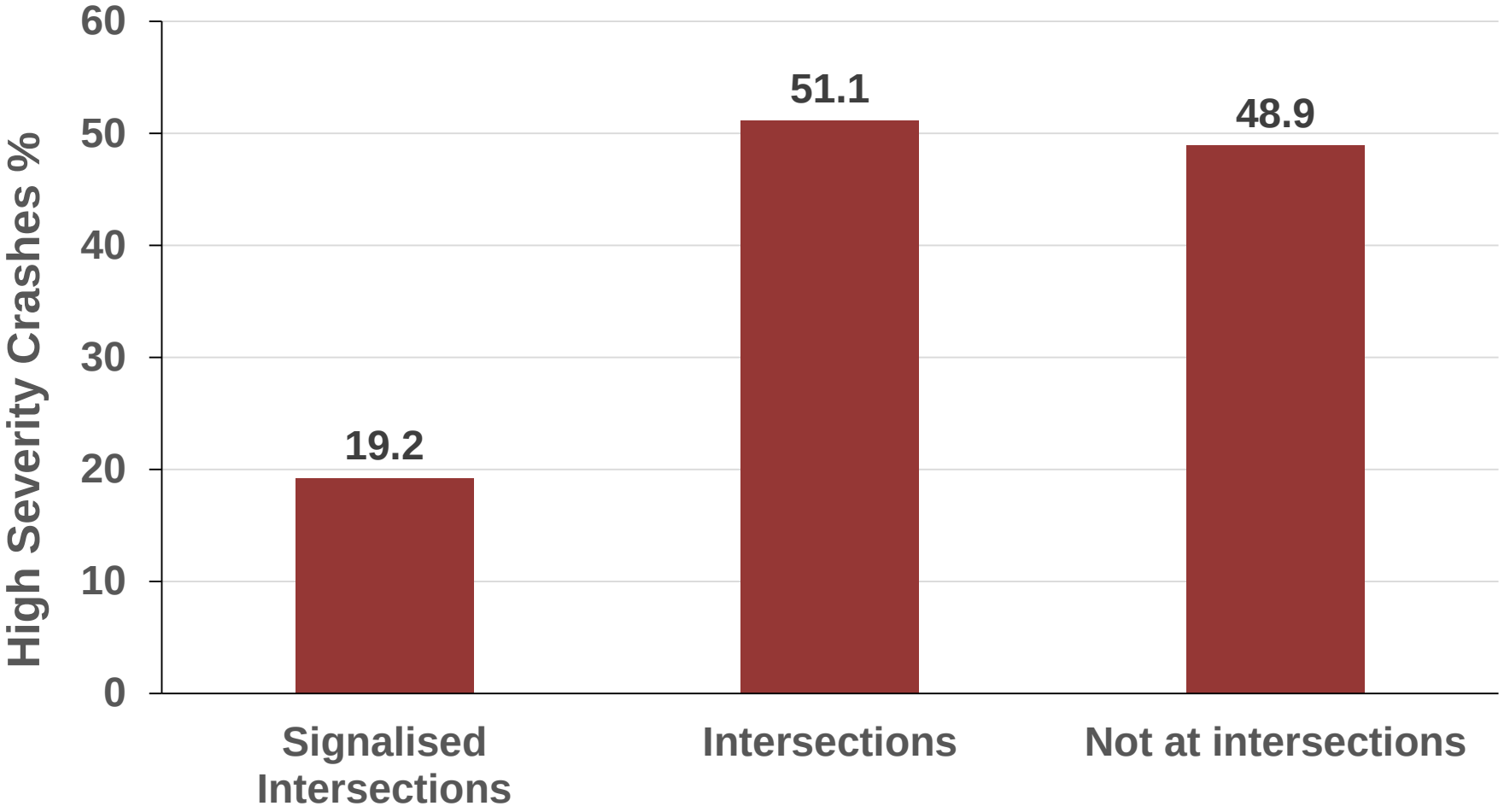
The aim of this study is to assess how pavement surface condition affects performance of signalised intersections in terms of safety.

Study Objectives

- Study how the variation in pavement surface condition affects rate, severity and types of crashes.
- Assess the contribution of condition variables to crash occurrence.
  - This study involves a before and after assessment.
  - The sample includes only sites that were subject to surface treatment during the study period.

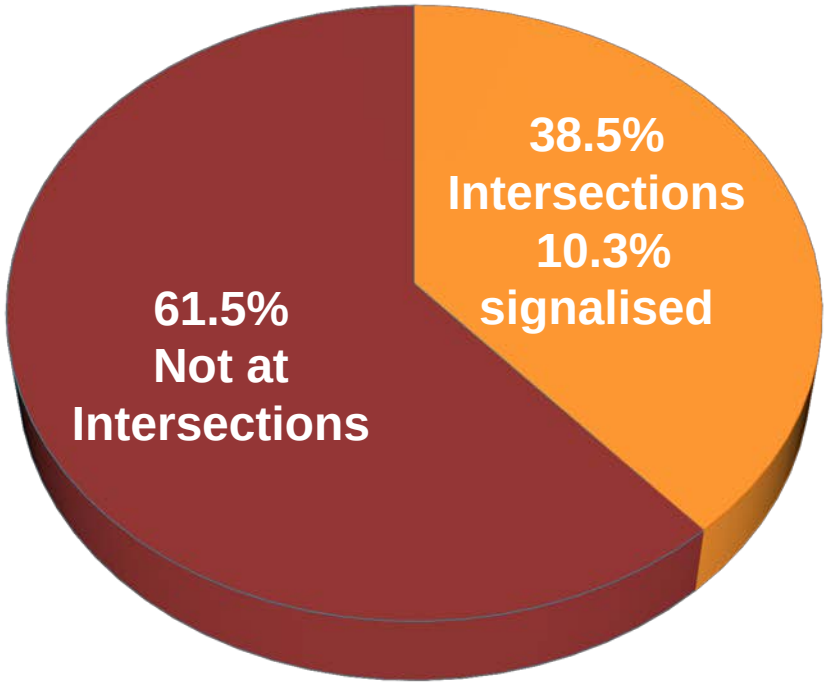
Study Area

High Severity (Fatality & Serious Injury) Crash Data (2000-2013)



Study Area
Fatality Crash Data (2000-2013)

- There are nearly 3700 intersections in the study area. At least 670 of them are signalised.



Data Collection
(Site Selection)

A large sample of intersections has been identified for which data (condition and crash) over ten year (2003-2013) is available

Filtering intersections using latitude and longitude coordinates in Google map to remove unsignalised intersections

One hundred sites were identified following a staged filtering process

Data Collection
(Site Selection)

Intersection included:

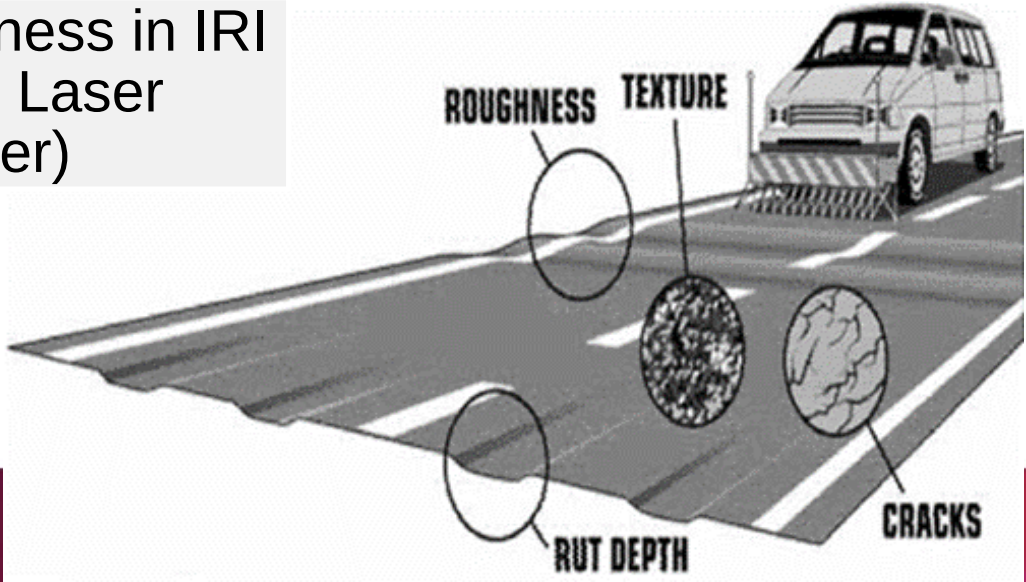
- Only intersections (or the immediate 200 m approach) that were subject to Surface treatment.
- Only intersections with crash data over 3 to5 years before and after treatment.

- For assessment and analysis, pavement condition data of treated length only was used.

Pavement Surface Condition Data

Road Surface Condition

- Skid Resistance in SFC, (SCRIM)
- Pavement Rutting in mm, (Multi Laser Profilometer)
- Pavement Roughness in IRI (m/km), (Multi Laser Profilometer)



Crash Data & Traffic Volume

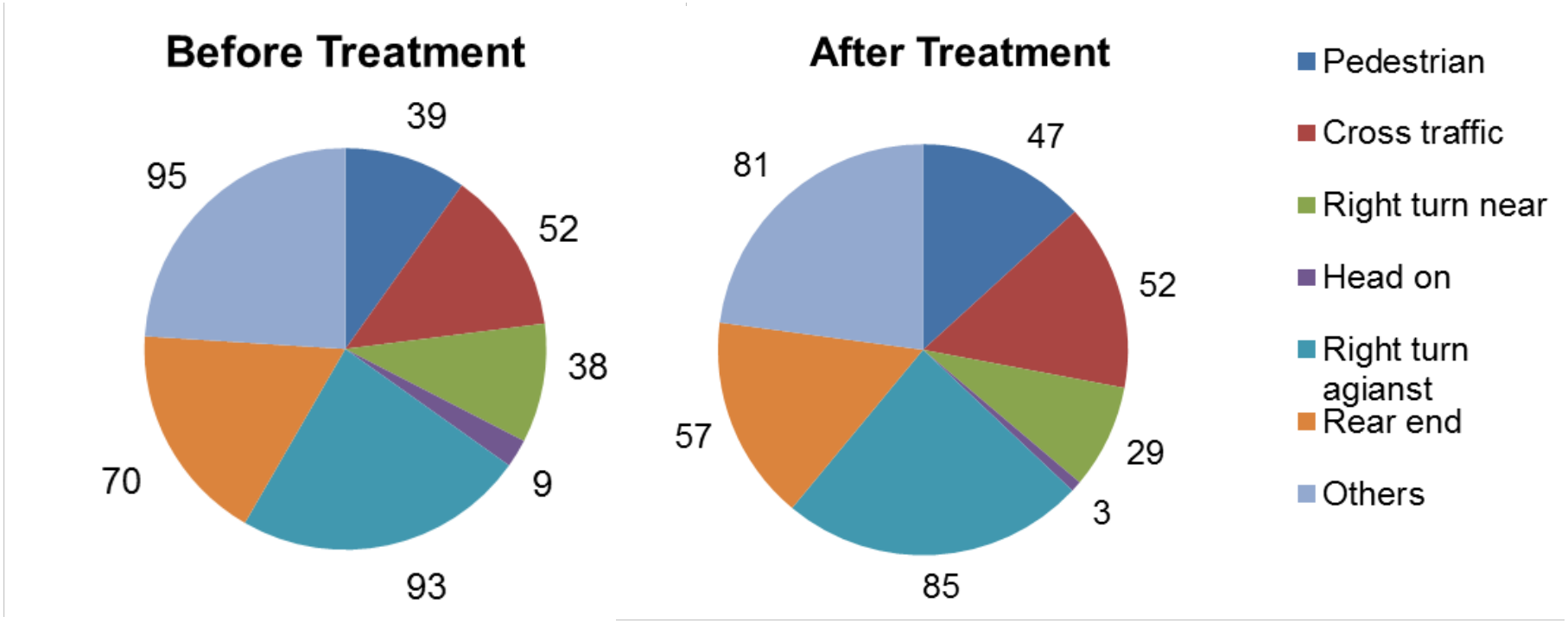
- Using Crash Stats (2014) database to obtain crash data for 3-5 years before and after treatment for each selected site.

- Traffic volume data for 3-5 years before and after treatment were collected from relevant road agency and used for calculating crash rates.

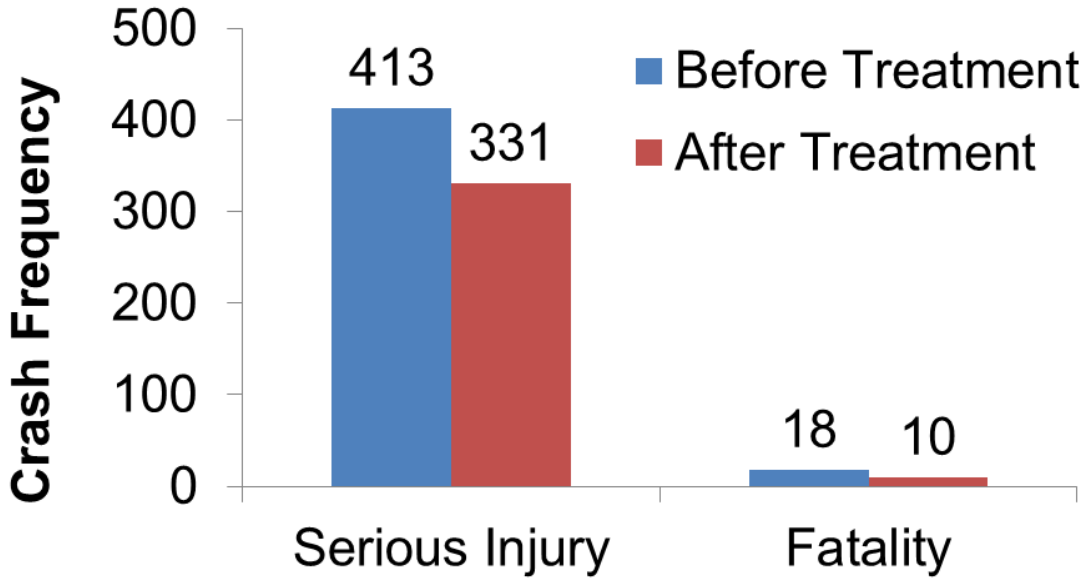
Analysis approach

- Descriptive analysis for distribution of crashes by different factors
- Assessment of before and after treatment
  - Paired Sample t-test
  - Graphical presentation
- Linear regression and univariate analysis using General Linear Model (GLM)
- Negative Binomial Regression using Generalised Linear Model

Descriptive Analysis (Distribution of crashes)

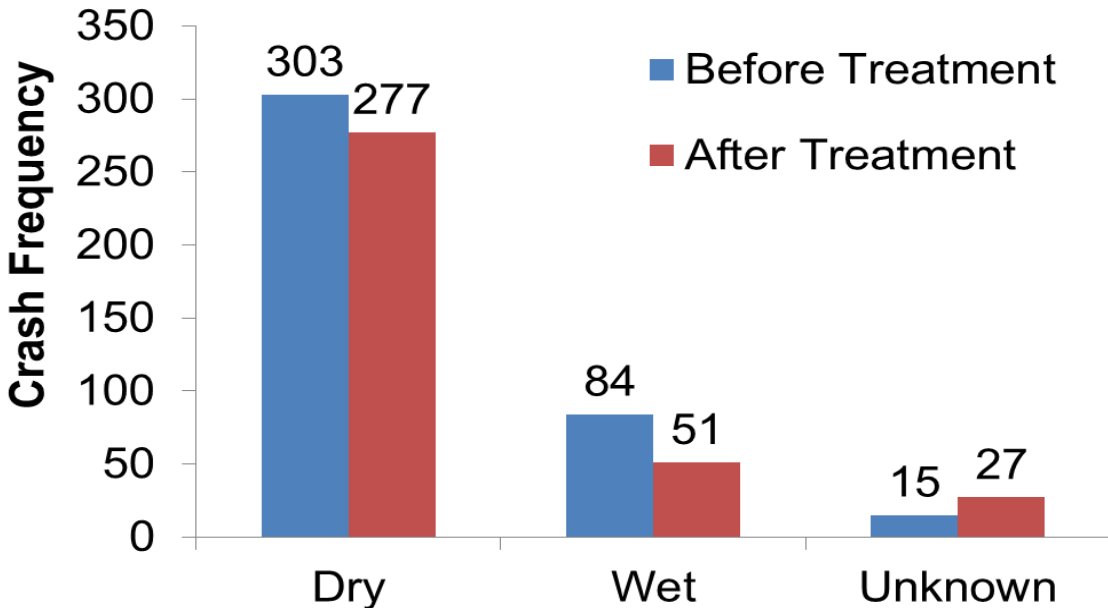


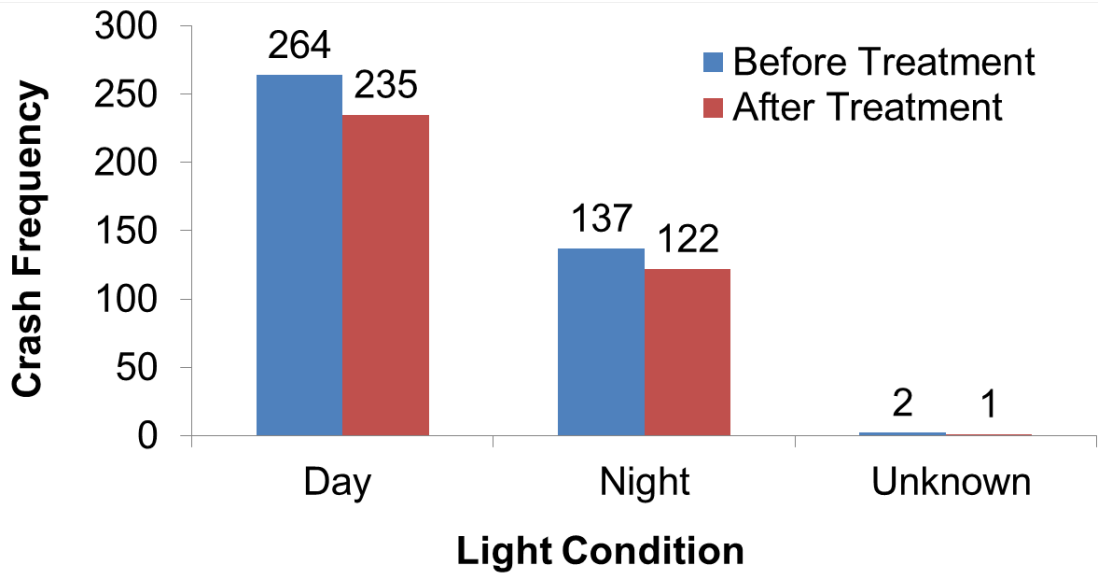
Distribution of Crashes by DCA Code (Type)



Distribution of Crashes by Severity

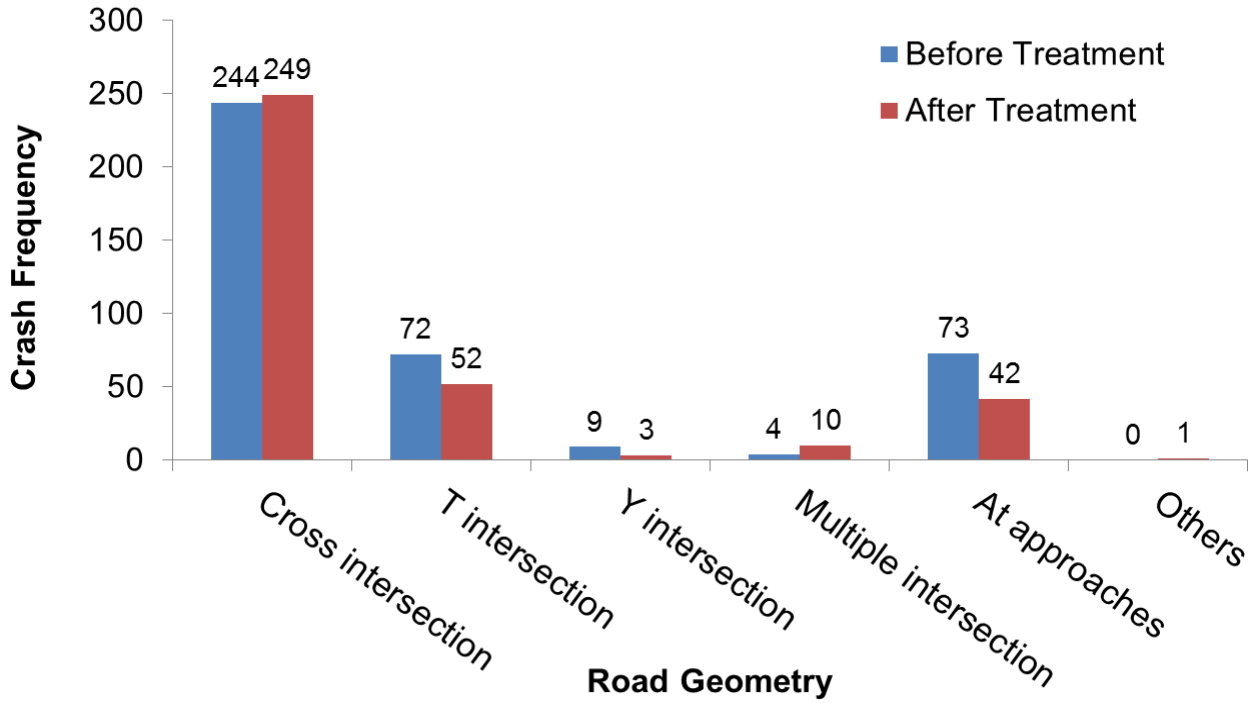
Distribution of Crashes by Surface Moisture Condition



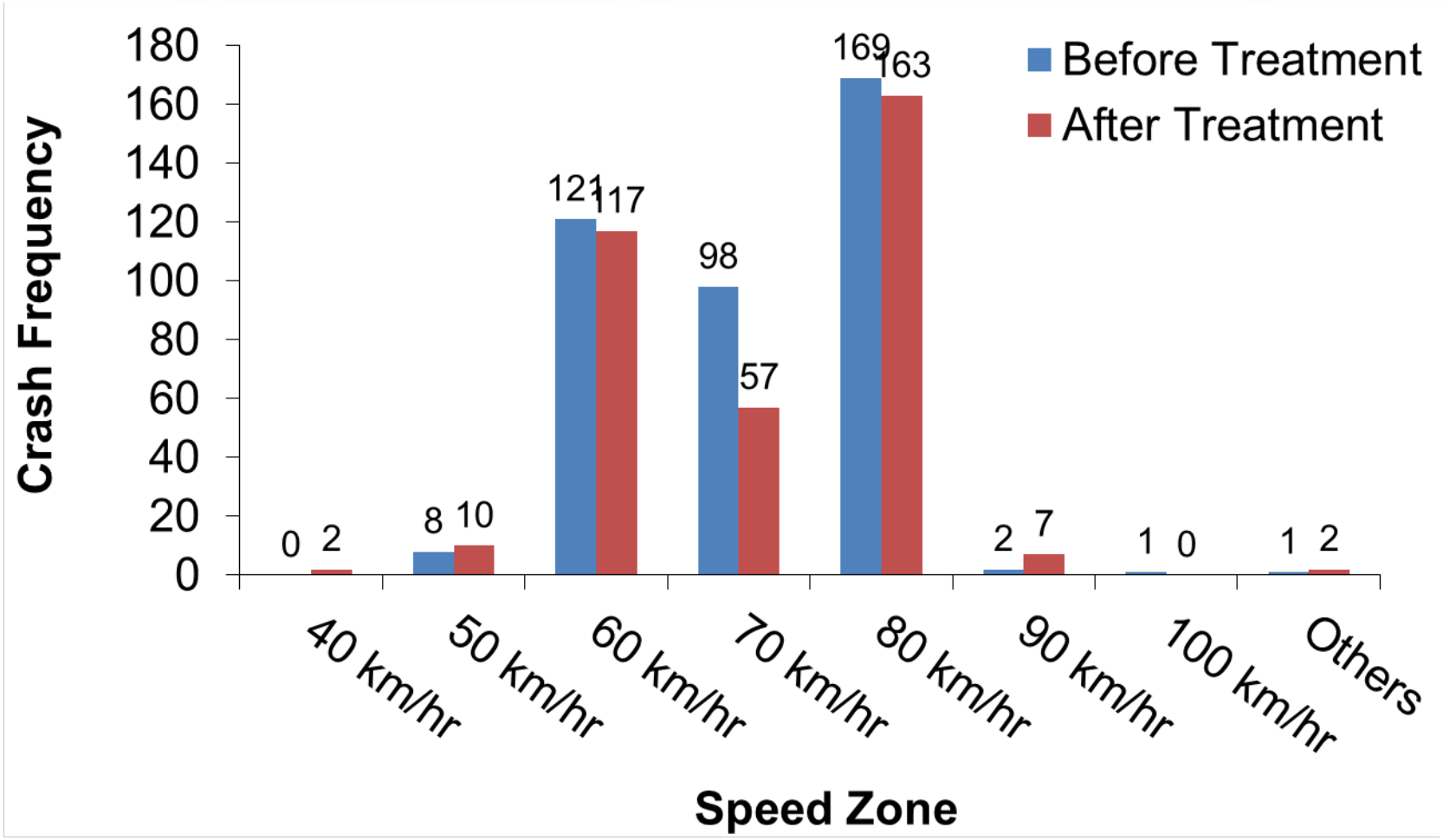


Distribution of Crashes by Light Condition

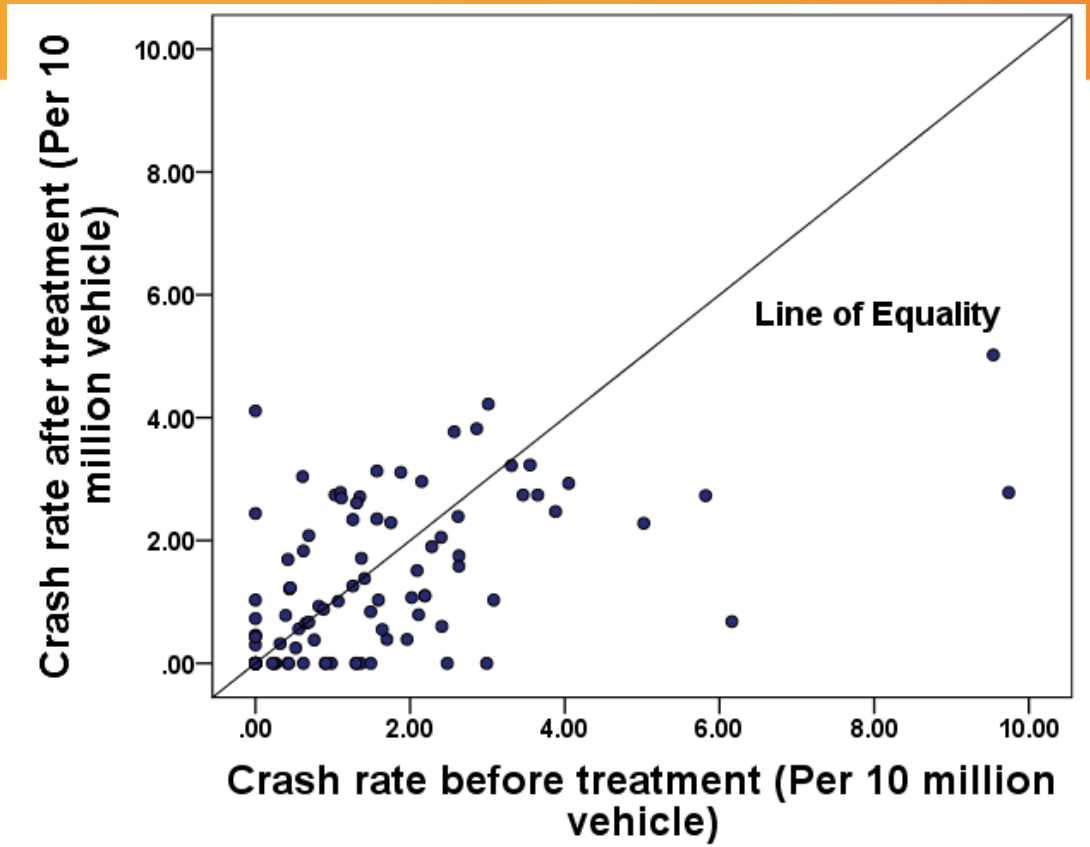
Distribution of Crashes by Road Geometry



Descriptive Analysis (Distribution of crashes)

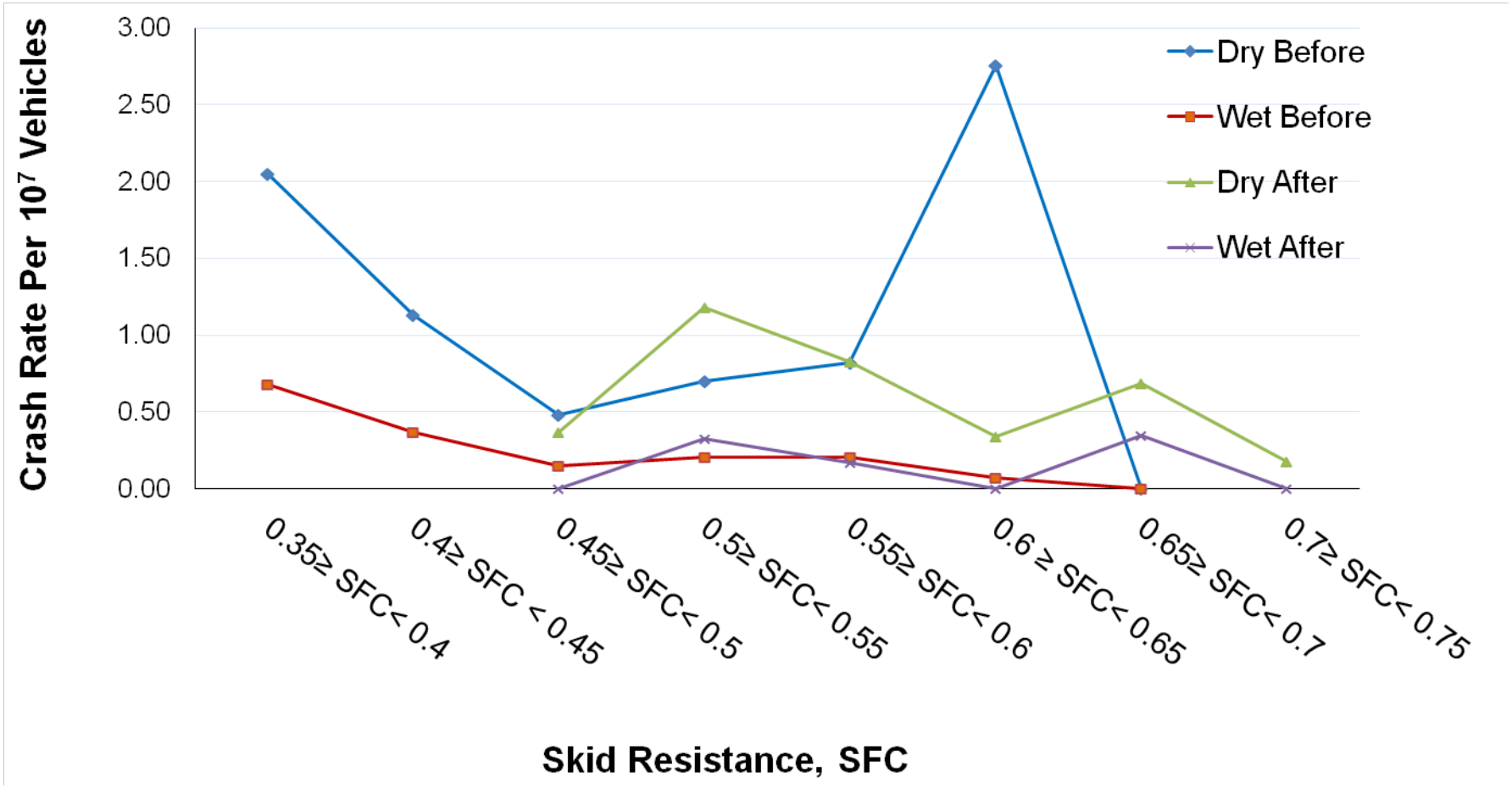


Assessment of before and after treatment

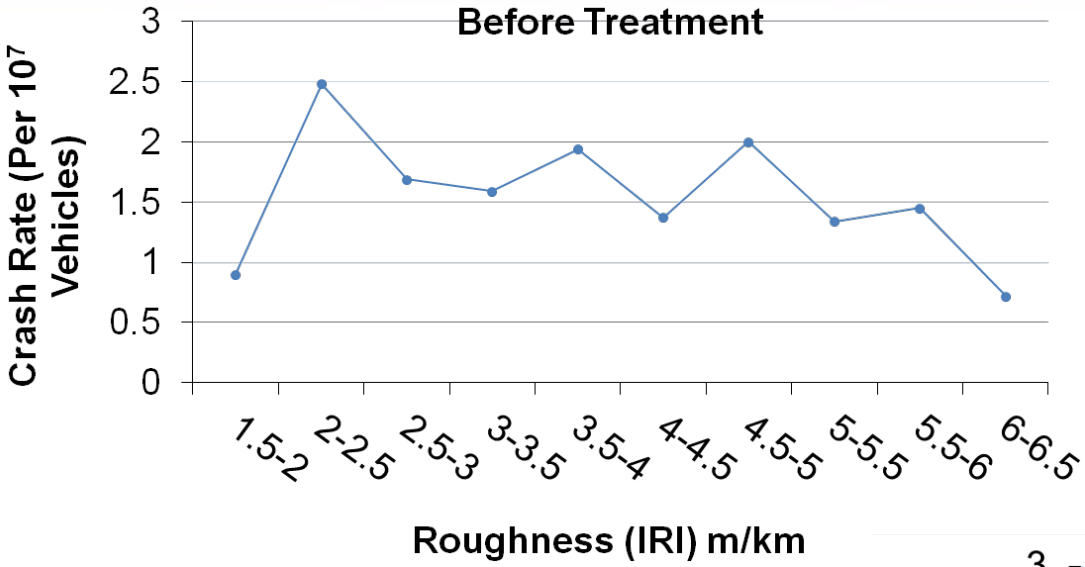


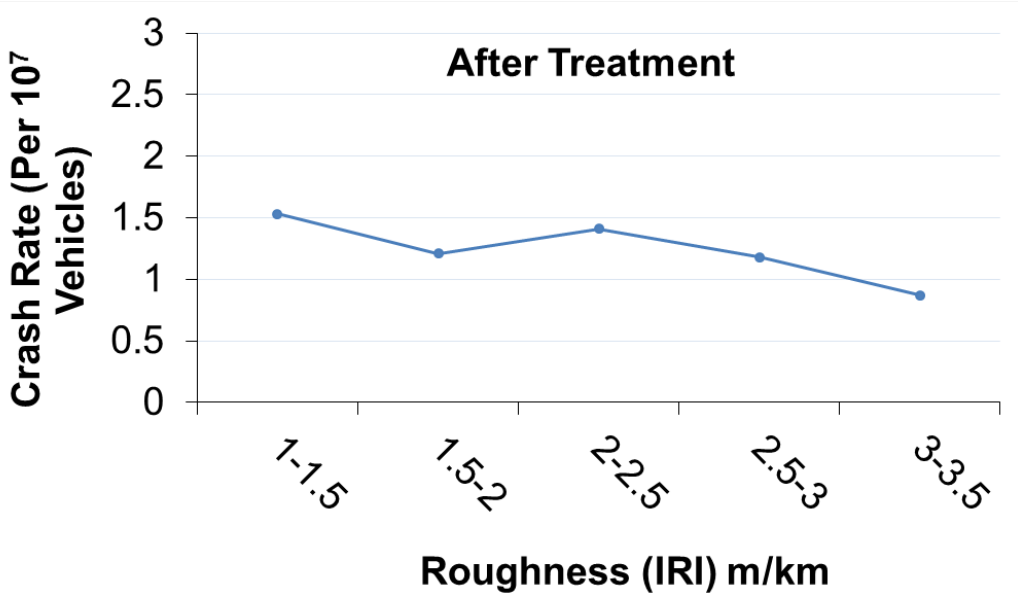
Type of Crash	Pairs	Mean Difference	Std. Deviation	t-stat	df	P value
High severity crashes	Crash rate before treatment Crash rate after treatment	0.49	2.09	1.93	98	0.006

High Severity Crashes vs Skid Resistance (SFC)

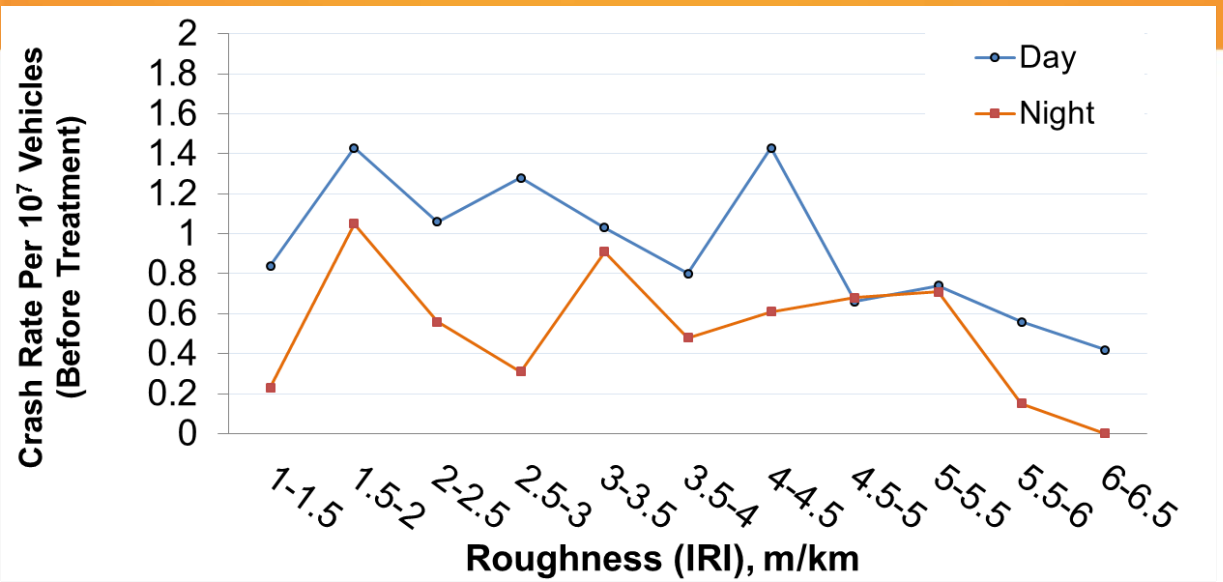


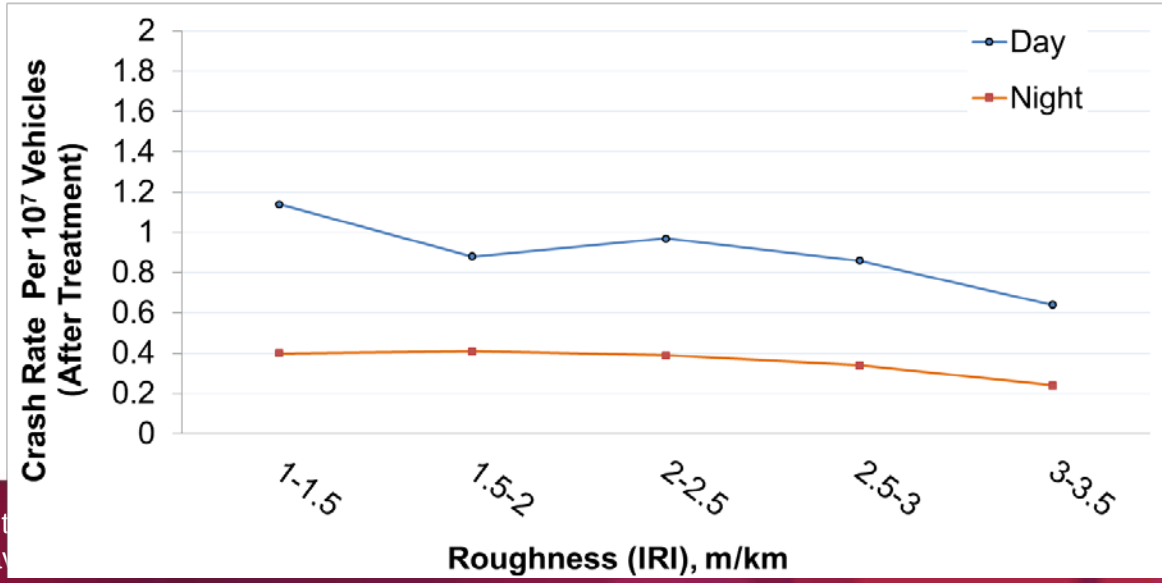
High Severity Crashes vs Roughness, IRI (m/km)



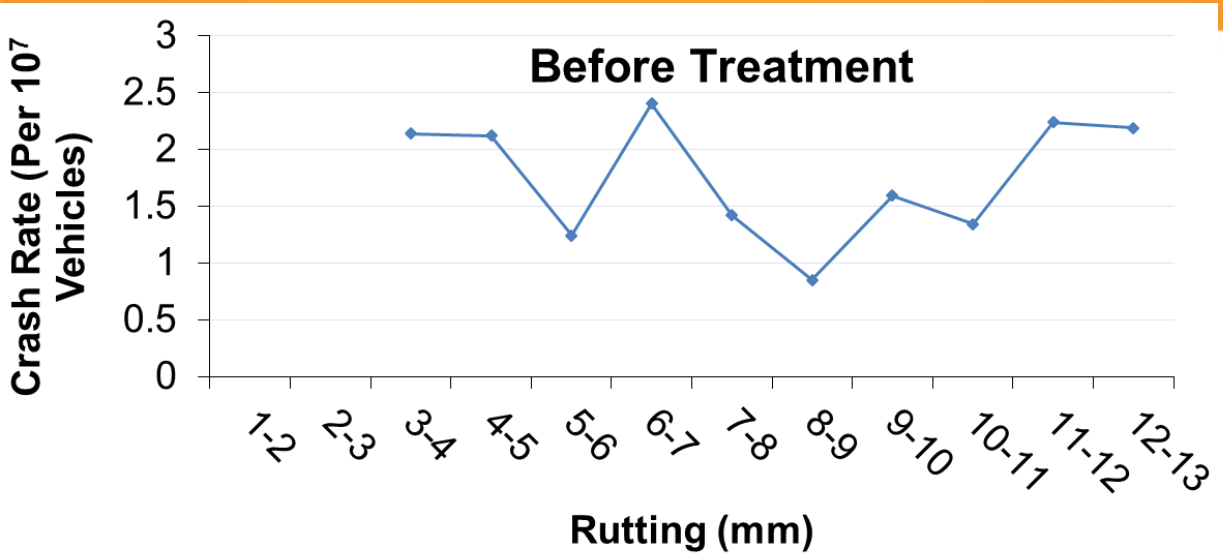


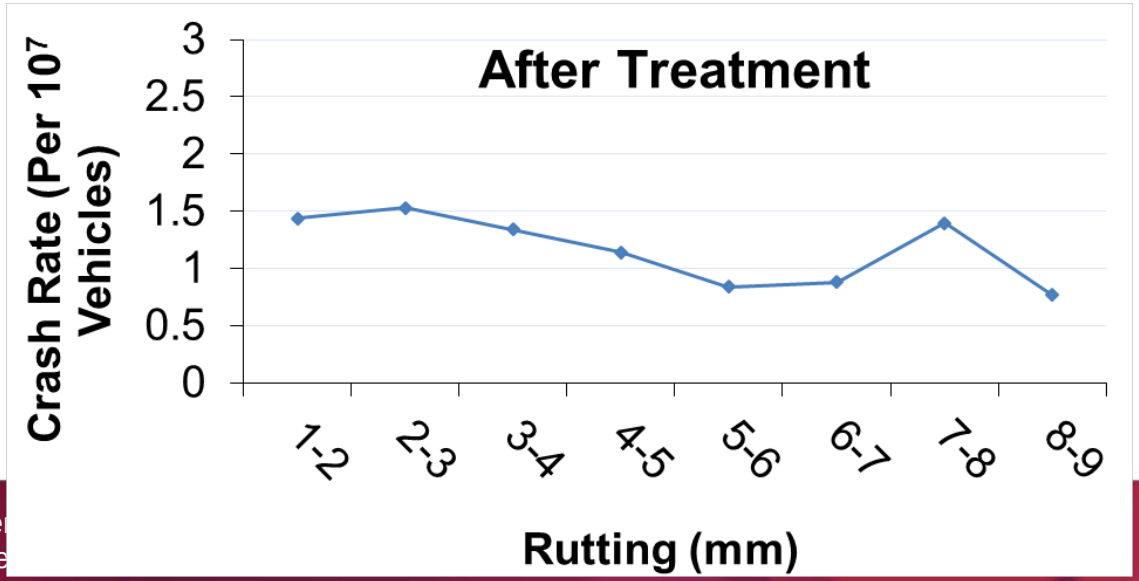
High Severity Crashes vs Roughness, IRI (m/km)



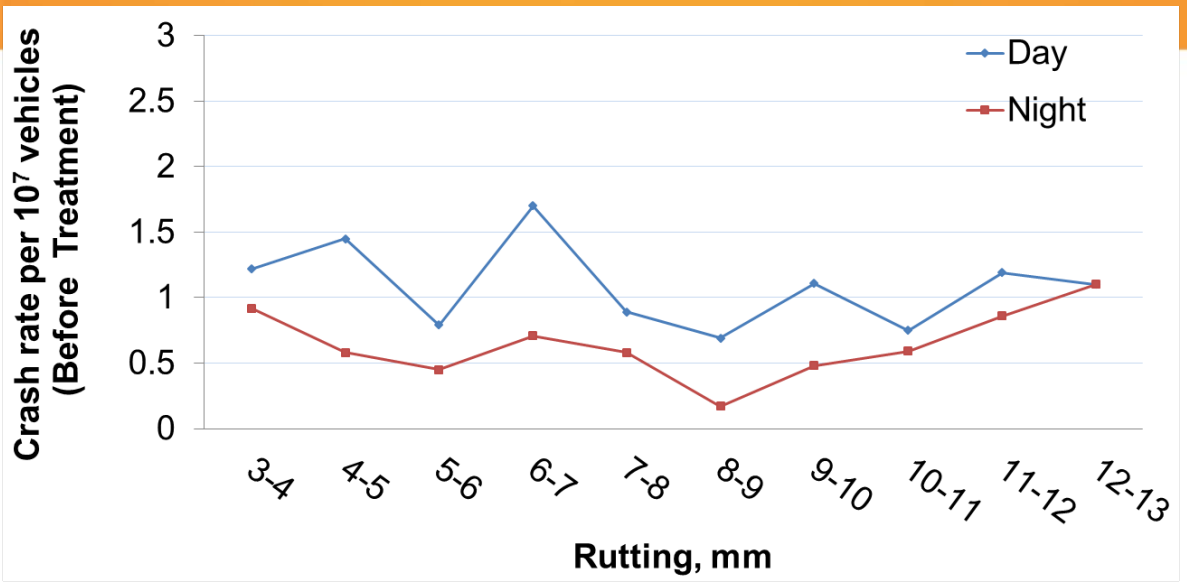


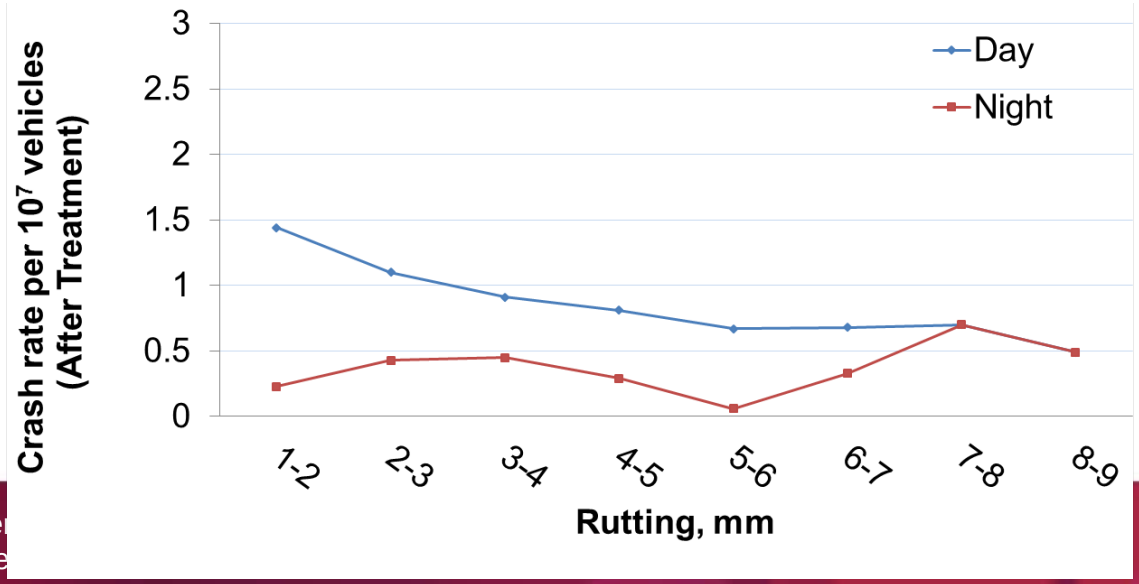
High Severity Crashes vs Rutting (mm)



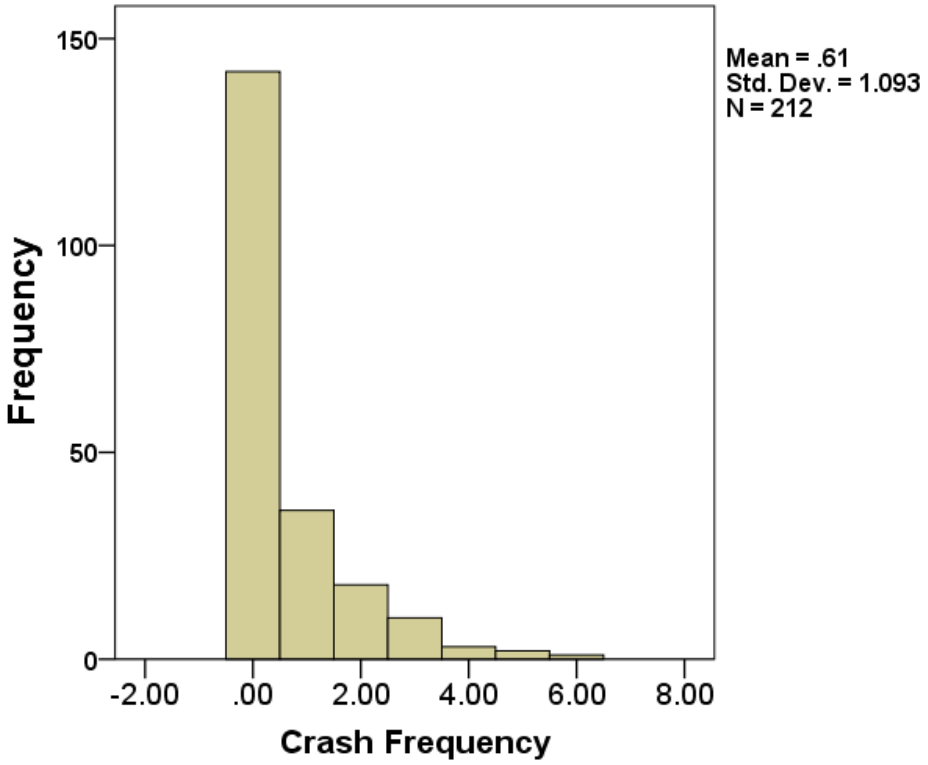


High Severity Crashes vs Rutting (mm)

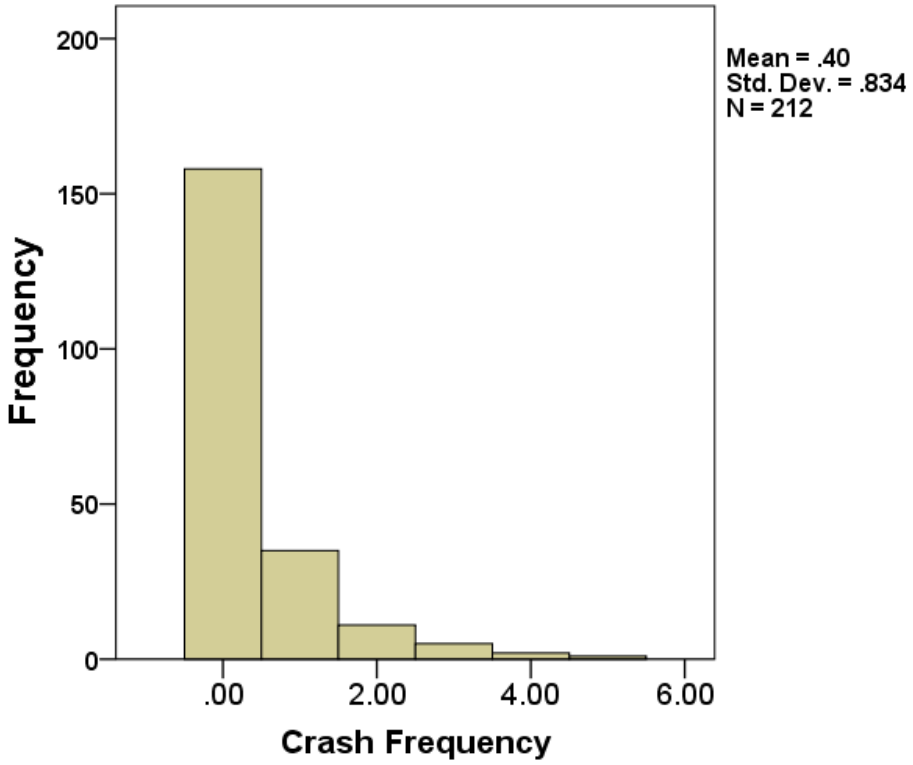




Negative Binomial Regression



Before Treatment



After Treatment

Statistical Analysis-Before Treatment

Parameters	High Severity Crashes (N=212)			
	Coefficient	Std Error	P value	Exp (B) IRR
(Intercept)	-.036	.1800	.843	.965
[Light_Condition, Night =.00]	-.450	.2366	.05	.638
[Light_Condition, Day=1.00]	0[a]	.	.	1
[Surface_MC, Wet =.00]	-1.206	.2525	.000	.299
[Surface_MC, Dry =1.00]	0[a]	.	.	1
CRoughness	-.017	.0983	.866	.984
CRutting	-.029	.0495	.563	.972
CSkid Resistance	-2.989	1.9668	.129	.050
CSpeed Limit	-.023	.0189	.227	.977
CSkid Resistance*Log Traffic Volume	-22.956	7.2699	.002	1.073E-10
CRoughness*Log Traffic Volume	.007	.5699	.990	1.007
CRutting*Log Traffic Volume	.044	.1768	.801	1.045
(Scale)	1[b]			
Negative binomial (Dispersion parameter)	.877	.3271		
Deviance/df	0.874			

Statistical Analysis-After Treatment

Parameters	High Severity Crashes (N=212)			
	Coefficient	Std Error	P value	Exp (B) IRR
(Intercept)	-.144	.1681	.392	.866
[Light_Condition, Night =.00]	-1.041	.2739	.000	.353
[Light_Condition, Day=1.00]	0[a]	.	.	1
[Surface_MC, Wet =.00]	-1.354	.2939	.000	.258
[Surface_MC, Dry =1.00]	0[a]	.	.	1
CRoughness	.047	.1498	.751	1.049
CRutting	-.118	.0866	.173	.889
Cskid Resistance	-1.575	2.4406	.519	.207
CSpeed Limit	.011	.0201	.573	1.011
CRutting* Log Traffic Volume	-.395	.2974	.184	.674
CRutting* Speed Limit	-.035	.0114	.002	.965
(Scale)	1[b]			
Negative binomial (Dispersion parameter)	.420	.2967		
Deviance/df	0.77			

Conclusions

1. Statistically significant reductions were observed between before and after treatment in average crash rates for high severity crashes.

2. Overall the results indicate that negative binomial model fits the data well and is a suitable model for applying in crash frequency analysis.

2. Skid Resistance
   a) The relationship of crash rate fluctuates with respect to the different categories of skid resistance but generally smaller percentages of crashes are associated with the higher SFC categories.
   b) Skid resistance has significant contribution to crash occurrence, before treatment, through its interaction with log traffic volume.

Conclusions

3. Surface Roughness
   a) Before treatment, a fluctuating relationship between crash rates and different categories of roughness was found
   b) After treatment, a decrease in crash rates was observed with increasing roughness.
   c) Has no significant contribution to crash occurrence before or after.
4. Rutting
   a) Before treatment a fluctuating pattern with a non obvious trend can be observed.
   b) After treatment the higher ranges of rutting are associated with lower crash rates.
   c) Has a significant contribution to crash occurrence, after treatment, through its interaction with speed limit.

Thank you for your attention