Data-Driven Safety Training
Freeway Segment Safety Analysis

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Outline

1 Safety analysis methodology and segmentation

2 Data requirements

3 Laclede I-44 example

4 Laclede I-44 solution

ISATe

General steps

- Main worksheet – enter general and crash data descriptions
- Hit “Clear” button before starting input for new site
- Input Freeway Segments
- Main worksheet – Perform Calculations

Main Worksheet

- General information
  - project description
  - contiguous years of analysis 2012-2014
- Crash data description
- freeway segments - 2012-2014
  - ramp segments and terminals – not part of the example

ISATe

- General Information – Main worksheet
  - project, analyst, date, area, analysis years
  - observed crash years

Enhanced Interchange Safety Analysis Tool						
General Information						
Project description:	I-44 Lebanon 4-lane Urban Freeway Segment Example					
Analyst:	cs	Date:	12/19/20	Area type:	Urban	
First year of analysis:	2012					
Last year of analysis:	2014					
Crash Data Description						
Freeway segments	Data for each individual segment		First year of crash data:	2012	Last year of crash data:	2014

Input Freeway Segments

- Basic roadway data
- # of through lanes – 4
- Freeway segment description – Station 120+07.71
- Segment length – 1.1 miles

Input Worksheet for Freeway Segments

Clear | Echo Input Values (View results in Column AV) | Check Input Values (View results in Advisory Messages)

	Segment 1	
	Crash Period	**Study Period**
Basic Roadway Data		
Number of through lanes (n):	4	4
Freeway segment description:	Station 120+07.71	
Segment length (L), mi:	1.1	1.1

Input Freeway Segments

Cross Section

Data

Input Worksheet for Freeway Segments			
Clear	Echo Input Values (View results in Column AV)	Check Input Values (View results in Advisory Messages)	Segment 1 Crash Period	Segment 1 Study Period
	Length of curve in segment ($L_{c3,seg}$), mi:			
Cross Section Data				
Lane width (W_l), ft:			12	12
Outside shoulder width (W_s), ft:			8	8
Inside shoulder width (W_{is}), ft:			4	4
Median width (W_m), ft:			40	40
Rumble strips on outside shoulders?:			Yes	Yes
	Length of rumble strips for travel in increasing milepost direction, mi:		1.1	1.1
	Length of rumble strips for travel in decreasing milepost direction, mi:		1.1	1.1
Rumble strips on inside shoulders?:			Yes	Yes
	Length of rumble strips for travel in increasing milepost direction, mi:		1.1	1.1
	Length of rumble strips for travel in decreasing milepost direction, mi:		1	1
Presence of barrier in median:			Center	Center
1	Length of barrier ($L_{ib,1}$), mi:		1.1	1.1
	Distance from edge of traveled way to barrier face ($W_{off,in,1}$), ft:		19.25	19.25
Median barrier width (W_{ib}), ft:			1.5	1.5

Input Freeway Segments

Roadside Data

Input Worksheet for Freeway Segments

Clear | Echo Input Values (View results in Column AV) | Check Input Values (View results in Advisory Messages)

		Segment 1 Crash Period	Segment 1 Study Period
Roadside Data			
	Clear zone width (W_{hc}), ft:	30	30
	Presence of barrier on roadside:	Some	Some
1	Length of barrier ($L_{ob,1}$), mi:	0.121	0.121
	Distance from edge of traveled way to barrier face ($W_{off,o,1}$), ft:		0

Input Freeway Segments

Ramp Access Data

EB/

Increasing

Input Worksheet for Freeway Segments

Clear | Echo Input Values (View results in Column AV) | Check Input Values (View results in Advisory Messages)

		Segment 1 Crash Period	Segment 1 Study Period
Ramp Access Data			
Travel in Increasing Milepost Direction			
Entrance Ramp	Ramp entrance in segment? (If yes, indicate type.):	No	No
	Distance from begin milepost to upstream entrance ramp gore ($X_{b,ent}$), mi:	0.328977	0.328977
	Length of ramp entrance ($L_{en,inc}$), mi:		
	Length of ramp entrance in segment ($L_{en,seg,inc}$), mi:		
	Entrance side?:		
Exit Ramp	Ramp exit in segment? (If yes, indicate type.):	No	No
	Distance from end milepost to downstream exit ramp gore ($X_{e,ext}$), mi:	0.049053	0.049053
	Length of ramp exit ($L_{ex,inc}$), mi:		
	Length of ramp exit in segment ($L_{ex,seg,inc}$), mi:		
	Exit side?:		
Weave	Type B weave in segment?:	No	No

Input Freeway Segments

Ramp Access Data

WB/

decreasing

Input Worksheet for Freeway Segments			
Clear / Echo Input Values (View results in Column AV) / Check Input Values (View results in Advisory Messages)		Segment 1 Crash Period	Segment 1 Study Period
Travel in Decreasing Milepost Direction			
Entrance Ramp	Ramp entrance in segment? (If yes, indicate type.):	No	No
	Distance from end milepost to upstream entrance ramp gore ($X_{e,ent}$), mi:	0.122917	0.122917
	Length of ramp entrance ($L_{en,dec}$), mi:		
	Length of ramp entrance in segment ($L_{en,seg,dec}$), mi:		
	Entrance side?:		
Exit Ramp	Ramp exit in segment? (If yes, indicate type.):	No	No
	Distance from begin milepost to downstream exit ramp gore ($X_{b,ext}$), mi:	0.132955	0.132955
	Length of ramp exit ($L_{ex,dec}$), mi:		
	Length of ramp exit in segment ($L_{ex,seg,dec}$), mi:		
	Exit side?:		
Weave	Type B weave in segment?:	No	No

Input Freeway Segments

- Freeway Segment AADT

Input Worksheet for Freeway Segments		
Clear / Echo Input Values (View results in Column AV) / Check Input Values (View results in Advisory Messages)		Segment 1
		Crash Period / Study Period
Traffic Data	**Year**	
Proportion of AADT during high-volume hours (P_{hv}):		
Freeway Segment Data	2012	32930
Average daily traffic ($AADT_{fs}$) by year, veh/d:	2013	27497
(enter data only for those years for which	2014	29221
it is available, leave other years blank)	2015	
	2016	

Input Freeway Segments

EB/Increasing Ramps

Input Worksheet for Freeway Segments		
Clear / Echo Input Values (View results in Column AV) / Check Input Values (View results in Advisory Messages)		Segment 1
		Crash Period / Study Period
Entrance Ramp Data for Travel in Increasing Milepost Dir.	**Year**	
Average daily traffic ($AADT_{b,ent}$) by year, veh/d:	2012	1456
(enter data only for those years for which	2013	1455
it is available, leave other years blank)	2014	1482
Exit Ramp Data for Travel in Increasing Milepost Direction	**Year**	
Average daily traffic ($AADT_{e,ext}$) by year, veh/d:	2012	3060
(enter data only for those years for which	2013	3060
it is available, leave other years blank)	2014	3107

Input Freeway Segments

WB/decreasing Ramps

Input Worksheet for Freeway Segments

Clear | Echo Input Values (View results in Column AV) | Check Input Values (View results in Advisory Messages)

		Segment 1 Crash Period	Segment 1 Study Period
Average daily traffic ($AADT_{e,ent}$) by year, veh/d:	2012	3325	
(enter data only for those years for which	2013	2645	
it is available, leave other years blank)	2014	2009	
Exit Ramp Data for Travel in Decreasing Milepost Direction	**Year**		
Average daily traffic ($AADT_{b,ext}$) by year, veh/d:	2012	1518	
(enter data only for those years for which	2013	1518	
it is available, leave other years blank)	2014	1544	

Output Summary

Output Summary						
General Information						
Project description:	I-44 Lebanon 4-lane Urban Freeway Segment Example					
Analyst:	cs	Date:	12/19/20	Area type:	Urban	
First year of analysis:	2012					
Last year of analysis:	2014					
Crash Data Description						
Freeway segments	Segment crash data available?		Yes	First year of crash data:	2012	
	Project-level crash data available?		No	Last year of crash data:	2014	
Ramp segments	Segment crash data available?		No	First year of crash data:		
	Project-level crash data available?		No	Last year of crash data:		
Ramp terminals	Segment crash data available?		No	First year of crash data:		
	Project-level crash data available?		No	Last year of crash data:		
Estimated Crash Statistics						
Crashes for Entire Facility	**Total**	**K**	**A**	**B**	**C**	**PDO**
Estimated number of crashes during Study Period, crashes:	14.5	0.1	0.3	1.9	3.1	9.0
Estimated average crash freq. during Study Period, crashes/yr:	4.8	0.0	0.1	0.6	1.0	3.0

Output Summary

- Predicted average total crashes = 4.8 crashes/year
- FI (KAB) = 0.799 crashes/year

Output Summary

Distribution of Crashes for Entire Facility

Crash Type	Crash Type Category	Estimated Number of Crashes During the Study Period					
		Total	K	A	B	C	PDO
Multiple vehicle	Head-on crashes:	0.0	0.0	0.0	0.0	0.0	0.0
	Right-angle crashes:	0.1	0.0	0.0	0.0	0.0	0.1
	Rear-end crashes:	4.0	0.0	0.1	0.6	1.0	2.2
	Sideswipe crashes:	1.3	0.0	0.0	0.1	0.2	0.9
	Other multiple-vehicle crashes:	0.1	0.0	0.0	0.0	0.0	0.1
	Total multiple-vehicle crashes:	5.6	0.1	0.1	0.8	1.3	3.2
Single vehicle	Crashes with animal:	0.1	0.0	0.0	0.0	0.0	0.1
	Crashes with fixed object:	6.4	0.1	0.1	0.8	1.3	4.1
	Crashes with other object:	1.0	0.0	0.0	0.1	0.1	0.8
	Crashes with parked vehicle:	0.1	0.0	0.0	0.0	0.0	0.1
	Other single-vehicle crashes	1.3	0.0	0.0	0.2	0.4	0.6
	Total single-vehicle crashes:	8.9	0.1	0.2	1.1	1.8	5.8
	Total crashes:	14.5	0.1	0.3	1.9	3.1	9.0

Missouri Severity

KABCO

- K – fatal
- A – disabling
- B – evident, non-disabling
- C – probable, not apparent
- O – property damage only
- if FI = KAB
  - MV = 1.016 crashes/year
  - SV = 1.380 crashes/year

Output Freeway Segments

- CMFs
  - SV vs MV
  - ENR vs EXR
- e.g. outside shoulder 8 vs 10 ft
- e.g. shoulder rumble strip

Output Worksheet for Freeway Segments

MV = multiple-vehicle model
SV = single-vehicle model
ENR = ramp entrance model
EXR = ramp exit model

	Applicable Models (*y*)				Segment 1 Crash Period	Segment 1 Study Period
Crash Modification Factors						
Fatal-and-Injury Crash CMFs						
Horizontal curve ($CMF_{1,w,ac,y,fi}$):	MV		ENR	EXR	1.000	1.000
		SV			1.000	1.000
Lane width ($CMF_{2,w,ac,y,fi}$):	MV	SV	ENR	EXR	1.000	1.000
Outside shoulder width ($CMF_{8,fs,ac,sv,fi}$):		SV			1.138	1.138
Inside shoulder width ($CMF_{3,w,ac,y,fi}$):	MV	SV	ENR	EXR	1.035	1.035
Median width ($CMF_{4,w,ac,y,fi}$):	MV		ENR	EXR	1.054	1.054
		SV			0.982	0.982
Median barrier ($CMF_{5,w,ac,y,fi}$):	MV	SV	ENR	EXR	1.009	1.009
Shoulder rumble strip ($CMF_{9,fs,ac,sv,fi}$):		SV			0.816	0.816
Outside clearance ($CMF_{10,fs,ac,sv,fi}$):		SV			0.997	0.997
Outside barrier ($CMF_{11,fs,ac,sv,fi}$):		SV			1.010	1.010
Lane change ($CMF_{7,fs,ac,mv,fi}$):	MV					
			Year:	2012	1.027	1.027
				2013	1.027	1.027
				2014	1.027	1.027

Output Freeway Segments

- Various EB outputs, include MV, SV, FI, PDO,

MV Expected Crash Frequency FI only

Low overdispersion

Expected close to Predicted

Output Worksheet for Freeway Segments						
MV = multiple-vehicle model SV = single-vehicle model	ENR = ramp entrance model EXR = ramp exit model				Segment 1	
	Applicable Models (*y*)				Crash Period	Study Period
		SV			1.000	1.000
Expected Average Crash Frequency						
Fatal-and-Injury Crash Frequency						
Freeway Segment Multiple-Vehicle Crash Analysis				Year		
Overdispersion parameter ($k_{fs,n,mv,fi}$):					0.052	
Observed crash count ($N^*_{o,fs,n,mv,fi}$), crashes:					1	
Reference year (r):					2012	
Predicted average crash freq. for reference year ($N_{p,fs,n,mv,fi,r}$), crashes/yr:					0.962	
Equivalent years associated with crash count ($C_{b,fs,n,mv,fi,r}$), yr:					2.602	
Expected average crash freq. for reference year given N^*_o ($N_{e,fs,n,mv,fi,r}$), crashes/yr:					0.896	
Expected average crash frequency ($N_{e,fs,n,mv,fi}$), crashes/yr:				2012	0.896	0.896
				2013	0.685	0.685
				2014	0.750	0.750

Output Freeway Segments

SV Expected Crash Frequency
FI only

Also low overdispersion

Expected close to Predicted

Freeway Segment Single-Vehicle Crash Analysis	Year		
Overdispersion parameter ($k_{fs,n,sv,fi}$):		0.030	
Observed crash count ($N^*_{o,fs,n,sv,fi}$), crashes:		1	
Reference year (r):		2012	
Predicted average crash freq. for reference year ($N_{p,fs,n,sv,fi,r}$), crashes/yr:		1.203	
Equivalent years associated with crash count ($C_{b,fs,n,sv,fi,r}$), yr:		2.816	
Expected average crash freq. for reference year given N^*_o ($N_{a,fs,n,sv,fi,r}$), crashes/yr:		1.124	
Expected average crash frequency ($N_{e,fs,n,sv,fi}$), crashes/yr:	2012	1.124	1.124
	2013	1.001	1.001
	2014	1.041	1.041

Missouri Calibration

Urban Four-Lane Freeway Segments (FI SV)	**0.60**
Urban Four-Lane Freeway Segments (FI MV)	0.71

FI only

- MV predicted crashes x C = 1.016 x 0.6 = 0.610 crashes/year
- SV predicted crashes x C = 1.380 x 0.7 = 0.980 crashes/year

Missouri Severity Distribution

- HSM predicted crashes x MO distribution/proportions
  - 4.8 crashes/year x MO distribution/proportions
  - can also apply MO calibration factors by severity

Site type	Fatal	Severe Injury	Minor Injury	PDO	FI
Urban Four- and Six-Lane Freeway Segments	0.004	0.022	0.216	0.759	0.241

MO Severity Dist.	Fatal	Severe Injury	Minor Injury	PDO	FI
HSM predicted	0.0192	0.1056	1.0368	3.6232	1.1568