Evaluation of Transverse Thermoplastic Pavement Markings for Speed Reduction in Costa Rica

Javier Zamora-Rojas
Road Safety Engineer (MScE)
Lanamme – University of Costa Rica

Didier E. Fonseca-Obando
Civil Engineer - Hermanos Brenes Construction Company, Costa Rica

25th Canadian Multidisciplinary Road Safety Conference,
25e Conférence canadienne multidisciplinaire sur la sécurité routière

UNIVERSIDAD DE COSTA RICA

LanammeUCR
LABORATORIO NACIONAL

PITRA
programa de infraestructura del transporte

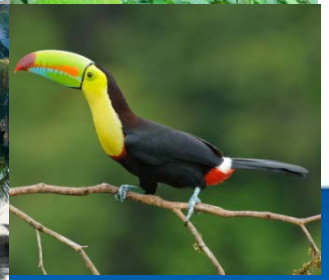
Costa Rica





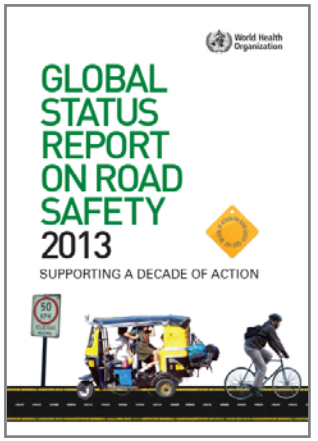


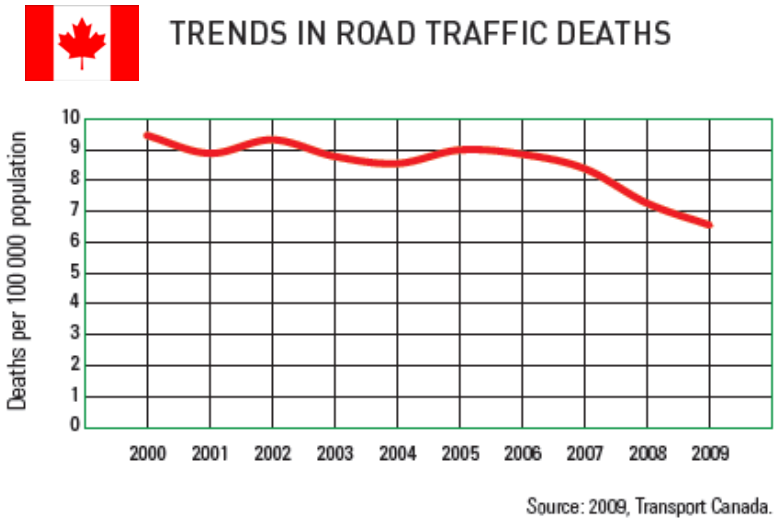


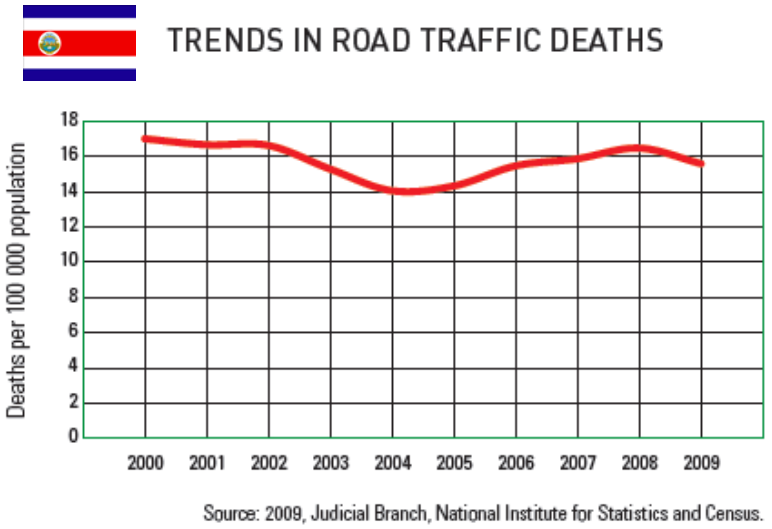



Introduction

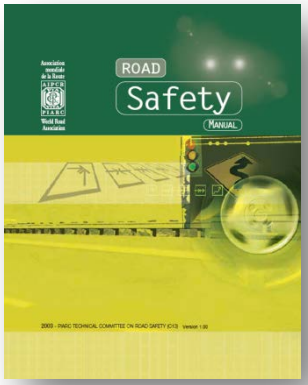
- **Speeding** → major worldwide problem

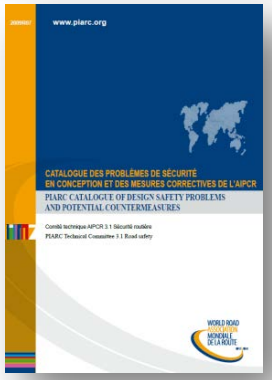


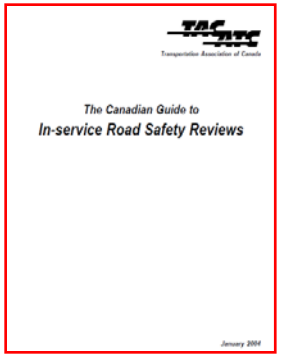


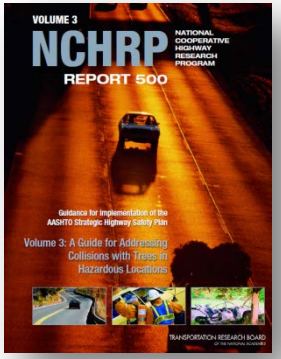


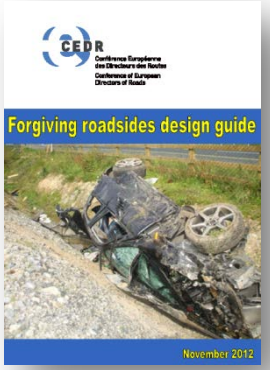
Road Safety Manuals











Provide Transverse Markings/ Rumble Strips	• Typically provided at rural intersections approaching a Stop sign • Warn drivers of upcoming cross-streets, and increases level of awareness	• 40% to 60% of all crashes	

Road Safety Manual

ROAD SAFETY MANUAL *for* COSTA RICA

LANAMME
(University of Costa Rica)

Road Safety Manual

Road Safety Management

Traffic Accident Analysis

Road Safety Countermeasure Catalog

Transverse Pavement Markings for Speed Reduction

Example of transverse markings in the Road Safety Manual:

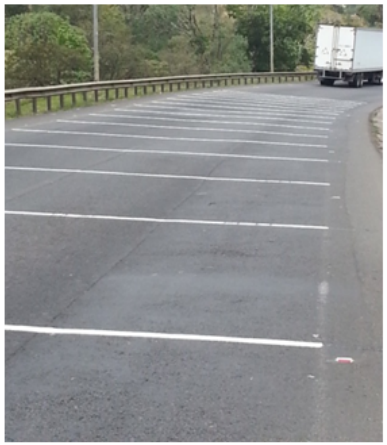
A8 **Líneas reductoras de velocidad**

Tipo de vía sugerido	Entorno vial sugerido		Usuarios beneficiados	Plazo sugerido (Factibilidad)	Etapa de la vía o del proyecto
Autopista (Alta velocidad)	Urbano	Rural	Conductores y pasajeros	Corto plazo	Planificación y diseño
Vía principal (TPDA alto)	Urbano	Rural	Peatones y/o ciclistas	Mediano plazo	Construcción y/o post-apertura
Vía secundaria (TPDA medio)	Urbano	Rural	Motociclistas	Largo plazo	Operación (Vía existente)
Calle residencial (TPDA bajo)	Urbano	Rural	Transporte público		Conservación y mantenimiento
			Terceras personas		

Descripción

Se denominan líneas reductoras de velocidad a una sucesión de líneas (u otros patrones de demarcación vial) que se colocan usualmente de manera transversal cubriendo totalmente o parcialmente el ancho de los carriles de circulación. Este tipo de líneas tienen como fin alertar a los conductores sobre condiciones de riesgo o sobre alguna otra situación en particular, que los incentive o incite a reducir la velocidad. [3,7]

Usos principales: Zonas escolares, cruce de peatones en vías de alta velocidad donde no haya puente peatonal, curvas peligrosas, antes de peajes, y antes de intersecciones con tendencia a excesos de velocidad.



- Countermeasure
- Reference Code
- Type of Road: Traffic (ADT)
- Road Environment: Urban/Rural
- Users that would benefit
- Short, medium, long term
- Project Stage
- Description
- Main uses
- Examples
- Design considerations

Methodology

Design and Evaluation of Transverse and Peripheral Pavement Markings
UNB, NB, Canada, year 2011
Supervisor: Eric D. Hildebrand, PhD, PEng

Speed Reduction ⟷ **Road Safety Culture**

Methodology

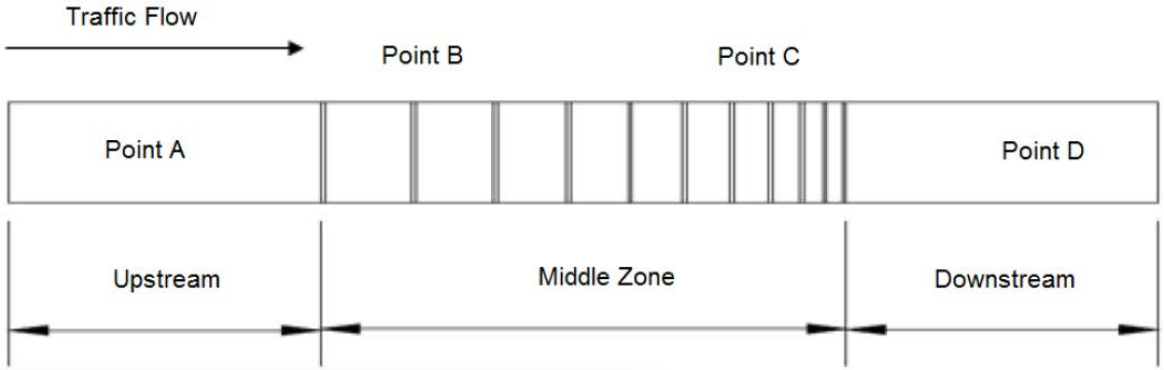
Fredericton, Canada

3M™ Stamark™ Preformed Tape

San José, Costa Rica

Double-layered Thermoplastic

Sites 1 & 2

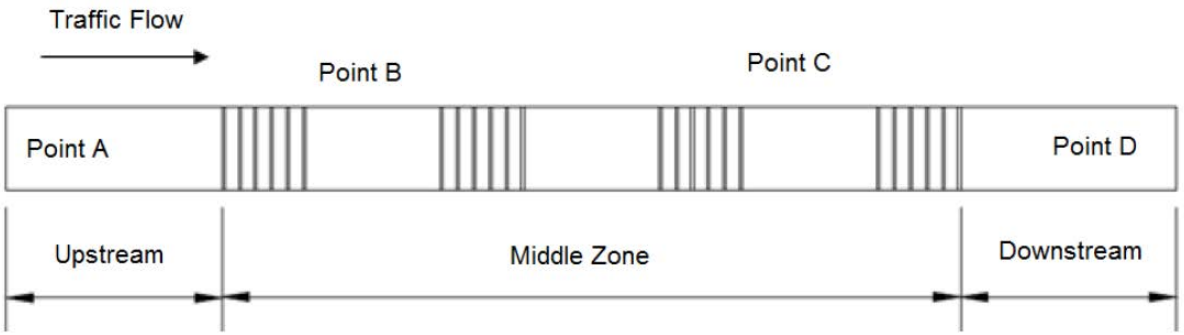


$$y = -3{,}94 \cdot \ln(x) + 15{,}49 \qquad (R^2 = 0{,}996)$$

Site 1


Calle 6
Av 10
Av 12
Río Tiribí
Río Tiribí
Río Tiribí
Río Tiribí
Río Chiquito
Río Chiquito
Túnel de Barrio La Carpintera
Deposito Irazu Tres Rios SA
Pan American Hwy
2
2

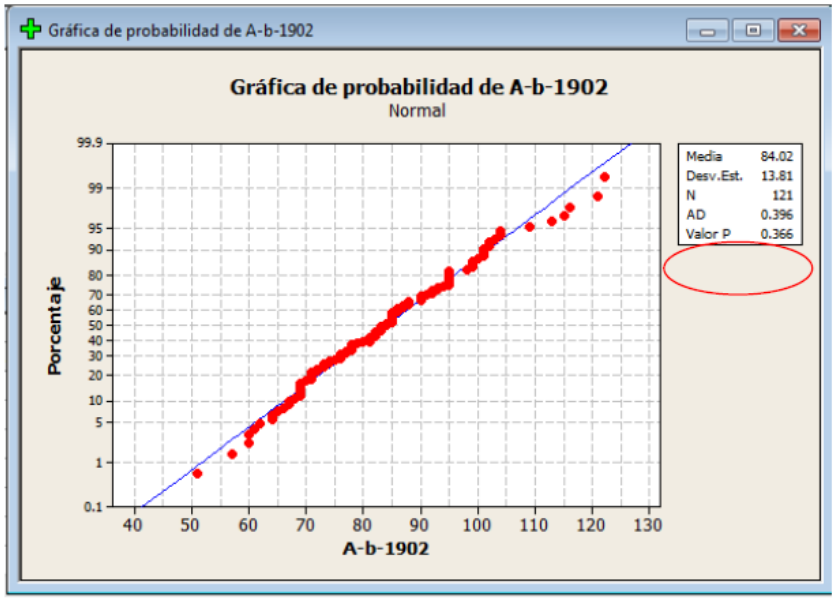
Site 3



- **4** groups of transverse lines with a separation of **30 m**
- Each group: **6** lines with a separation of **0.5** m

Statistical Analysis

Normality Tests
Software Minitab 15



Student's T-Test

$$s_{AB} = \sqrt{\frac{(n_1-1)\cdot s_1{}^2+(n_2-1)\cdot s_2{}^2}{(n_1+n_2-2)}}$$

$$t = \frac{|\bar{x}_1-\bar{x}_2|}{s_{AB}\cdot\sqrt{\frac{1}{n_1}+\frac{1}{n_2}}}$$

Level of Confidence: **95%**

Overall sample size:
≈ 4,000 speed data

Site 1

Main Results

SITE 1	Upstream	Middle Zone		Downstream
V_{85th} (BEFORE)	99.0 km/h	94.2 km/h		96.3 km/h
V_{avg} (BEFORE)	84.0 km/h	80.8 km/h		83.7 km/h
Posted Speed 				
V_{85th} (AFTER)	95.5 km/h	92.3 km/h	89.7 km/h	89.4 km/h
V_{avg} (AFTER)	86.4 km/h	83.5 km/h	80.9 km/h	80.6 km/h
Max. reduction V_{85th} (Before vs. After)	**7.4%**	**6.6%**	**9.7%**	**15.9%**
Max. reduction V_{avg} (Before vs. After)	0.7%	-0.8%	**3.7%**	**9.1%**
Avg. reduction V_{85th} (Point D vs. Point A)	|---------->			**6.4%**
Avg. reduction V_{avg} (Point D vs. Point A)	|---------->			**6.8%**

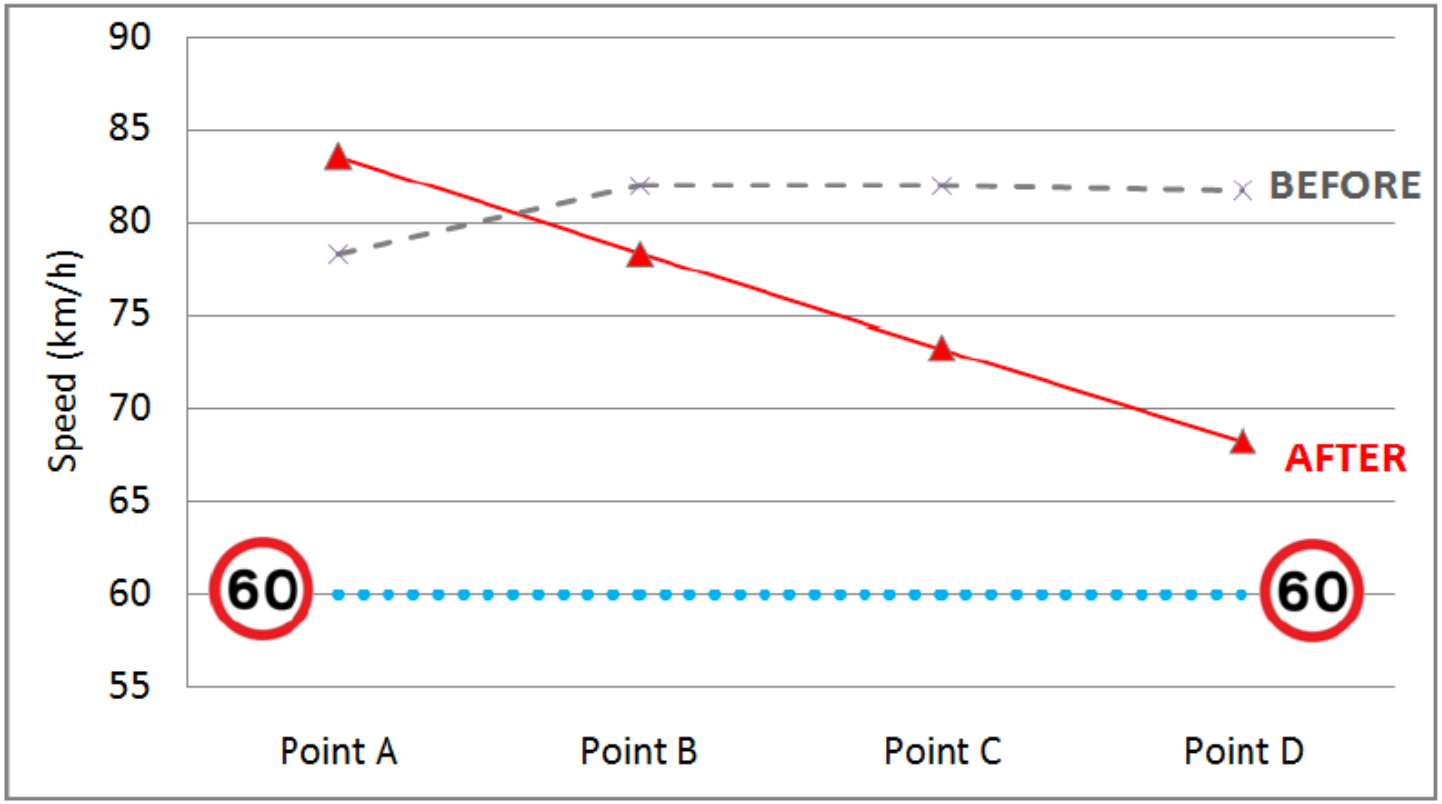
Site 2

Main Results

SITE 2	Upstream	Middle Zone		Downstream
V_{85th} (BEFORE)	78.3 km/h	82.0 km/h		81.7 km/h
V_{avg} (BEFORE)	71.3 km/h	75.3 km/h		71.6 km/h
Posted Speed 				
V_{85th} (AFTER)	83.6 km/h	78.3 km/h	73.3 km/h	68.3 km/h
V_{avg} (AFTER)	73.6 km/h	68.9 km/h	64.0 km/h	61.2 km/h
Max. reduction V_{85th} (Before vs. After)	3.4%	**15.9%**	**15.1%**	**19.2%**
Max. reduction V_{avg} (Before vs. After)	2.5%	**20.5%**	**18.5%**	**17.2%**
Avg. reduction V_{85th} (Point D vs. Point A)	|---------->			**18.3%**
Avg. reduction V_{avg} (Point D vs. Point A)	|---------->			**16.7%**

Site 2

Main Results



SAFETY
improvement

Site 3

Main Results

SITE 3	Upstream	Middle Zone		Downstream
V_{85th} (BEFORE)	69.0 km/h	65.3 km/h		61.3 km/h
V_{avg} (BEFORE)	61.0 km/h	57.4 km/h		54.8 km/h
Posted Speed 	Traffic Flow 			
V_{85th} (AFTER)	67.1 km/h	64.5 km/h	63.9 km/h	61.3 km/h
V_{avg} (AFTER)	58.5 km/h	55.5 km/h	52.8 km/h	53.6 km/h
Max. reduction V_{85th} (Before vs. After)	5.8%	4.1%	5.6%	2.6%
Max. reduction V_{avg} (Before vs. After)	6.4%	5.1%	**9.3%**	**9.7%**
Avg. reduction V_{85th} (Point D vs. Point A)	|---------->			**8.6%**
Avg. reduction V_{avg} (Point D vs. Point A)	|---------->			**8.3%**

Conclusions

- Most significant speed reductions were observed towards the end of the speed zone
- No novelty effect was observed
- Any speed reduction achieved is an improvement in safety

→ **Transverse markings are a good low-cost road safety speed reduction countermeasure… to be used wisely!!!**

- Road authority has placed transverse markings in work zones and approaching toll booths
- Driver's awareness: difficult to measure

UNIVERSIDAD DE COSTA RICA | LABORATORIO NACIONAL DE MATERIALES Y MODELOS ESTRUCTURALES

LanammeUCR

Questions?

javier.zamorarojas
@ucr.ac.cr