Volume 23
Issue 2

El Puente

Puerto Rico Transportation Technology Transfer Center Newsletter
University of Puerto Rico at Mayagüez

Inside this issue:

Traffic Management Strategies for Urban Areas

Demand for highway travel continues to grow in the United States and Puerto Rico as the population increases and suburbanization expands in the metropolitan areas. The lack of multimodal transportation options in Puerto Rico, except for the San Juan Metropolitan Area, has promoted the use of the private motor vehicle to satisfy the mobility needs of the population.

Puerto Rico has one of the highest motorization rates in the world, similar to the existing rate in the United States. The number of registered motor vehicles exceeds 3.1 million in the island, coupled with almost 4 million inhabitants. Construction of new roadway miles or the addition of capacity to accommodate the growth in travel could not keep pace in the island and could not be sustainable.

Different traffic management strategies have been implemented throughout urban areas around the world to control traffic congestion. This article presents an overview of some of these practices with their main advantages and disadvantages.

(Article continues on page 4)

Model for the Development of Municipal Bus Systems: SITRAC in Carolina, Puerto Rico

The municipality of Carolina, located in the San Juan Metropolitan Area of Puerto Rico, established its own local bus system to increase the mobility and mass transportation options of their residents and visitors. The local bus system serves both urban and rural communities in the municipality and is known as SITRAC (*Sistema Intermodal de Transportacion Carolinense*).

This article reviews the story of SITRAC and presents its characteristics and operation as a showcase of a potential model for other municipalities in the development of their municipal transportation systems.

(Article continues on page 8)

FHWA Guides to Improve Road Safety: Guardrail Repair and Vegetation Control

Putting in place effective road maintenance programs are essential to improve traffic safety. Road maintenance crews need to be properly trained to timely identify, assess, and correct inadequate or unsafe conditions associated to road infrastructure elements.

The Office of Safety of the Federal Highway Administration recently published two guides that could assist state and local road maintenance crews to identify and correct potential safety issues associated to W-beam guardrails and vegetation control.

Vegetation Control for Safety: A Guide for Local Highway and Street Maintenance Personnel

The purpose of this guide is to help local road agency maintenance workers identify locations where vegetation control is needed to improve traffic and pedestrian safety, to provide guidance for maintenance crews, and to make them aware of safe methods to mow, cut brush and otherwise control roadside vegetation.

The guide includes descriptions of conditions commonly found on local highways and streets and provides best practices for road workers to identify potential hazards caused by vegetation. Detailed information is presented about sight distance, worker safety, and setting up temporary traffic control.

W-Beam Guardrail Repair: A Guide for Highway and Street Maintenance Personnel

This guide focuses on how to repair the strong post W-beam guardrail, identified as SGR-04 in the Standardized Highway Barrier Hardware Guide.

The standard strong post W-beam guardrail consists of a W-beam rail element and strong posts (wood or steel) typically spaced at 6-ft 3-in with the rail blocked out from the posts.

The guide includes descriptions of categories of W-beam guardrail functionality for standard and transition sections and end treatments to identify safety issues. In addition, the guide suggest W-beam guardrail repair practices and maintenance checklists.

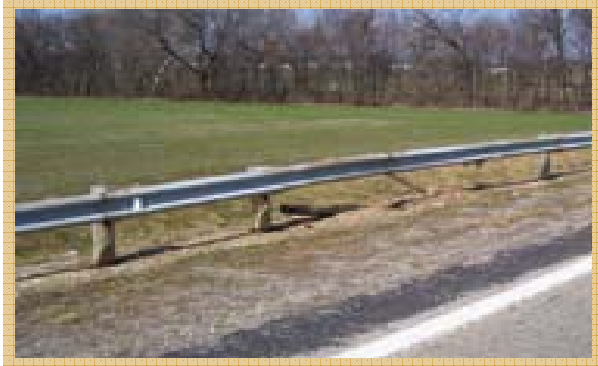
The guides are available at the following Internet address for free downloading:

http://safety.fhwa.dot.gov/local_rural/

Suggested Functionality Categories for Standard Sections of W-beam Guardrails [(a)]

1. Guardrail is no longer reasonably functional.

- W-beam element is separated completely
- W-beam element is torn
- Rail is bent or pushed more than 18 inches out of line, and/or less than 24 inches high
- Three or more posts are broken or bent over and separated from the rail



2. Guardrail should function adequately under a majority of impacts.

- Rail is bent or pushed less than 12 inches out of line with rail element intact
- One or two posts are broken or bent over and separated from the rail (element intact)

3. Damage should not affect the guardrail's ability to perform.

- Rail is bent or pushed less than 6 inches out of line with rail element intact
- Guardrail height is a minimum of 26 inches high

(a) - Source: FHWA W-Beam Guardrail Repair Guide

The assessment of the guardrail functionality condition must consider additional factors that include, but is not limited to, the highway classification, traffic volume and speed, guardrail location, roadside condition, crash history, and adherence to current guardrail installation standards.

Important Elements of Guardrail Inspection

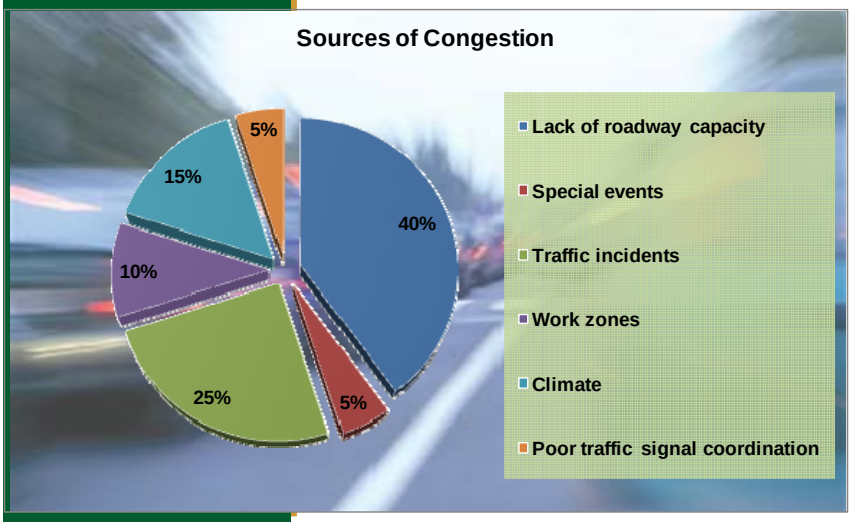
- Tension capability / anchor cable
- Rail height / consolidation of terrain
- Post spacing
- Wood / plastic block-out
- Posts firmly bedded / erosion in post foundation
- Available deflection distance in back of rail to object
- Corrosion in hardware components
- End treatments / transition sections

Traffic Management...

(continued from page 1)

Transportation can be studied as a system of supply and demand. Supply refers to the transportation infrastructure, transportation methods, and the way they are carried on. Demand establishes the mobility needs of people, goods, or services from one place to another.

Congestion is generated when the amount of vehicles exceeds the system's capacity. This occurs mainly in the morning and afternoon peak hours; increasing travel time, gas/oil consumption, environmental pollution, and reducing productivity and the free time available to spent with the family, among other problems.



Keeping congestion under control must be part of the long run strategic vision for a city's development. The following strategies have been implemented in various cities in order to control the supply or demand of transportation systems.

1. Parking Management

The need for parking spaces is indispensable for transportation systems that depends primarily of private motor vehicles.

Managing parking space is based on regulating the availability of lots destined to this use in the city. This alternative may limit vehicle flow reducing parking space on street sides and forcing people to leave their vehicles in selected areas in the city created for this purpose. This strategy entails restricting available spaces or charging a parking fee on streets, as well as providing alternative services for transportation to complement or replace private vehicle use.

Santiago de Chile issued a bill to introduce this measure. A number of municipalities hired private companies to manage parking space using people who handle electronic systems for this purpose. This measure generates employment and regulates the parking supply on the streets. In addition, around 4,400 underground lots were built, freeing 5,500 spaces on the street.

Advantages

- Income can be invested in improving the transportation system
- Drop in traffic pollution levels
- Low cost of implementing measure
- Generation of direct jobs
- Protection of sectors that present particular characteristics by lowering traffic flow

Disadvantages

- Opposition from population sectors due to routine use of private vehicles and the need for transportation and parking space
- Extreme measures or restrictions may cause a decrease in visitors to the area
- The need to provide residents with parking spaces and easy access to their homes

2. Vehicle Restriction by License Plate Number or Color

This measure consists of prohibiting access to vehicles in specific city sectors and during periods of time, mainly during peak hours and weekdays. The measure relies on the license plate's last digit for ID. Prohibiting two digits, each day, hypothetically, could reduce traffic by 20%. This measure is usually implemented in all city sectors or in a whole region, so that it will not generate confusion among users.

In 1998, Bogotá City in Colombia implemented this measure naming it "Pico y Placa". The strategy works by restricting four digits on the license plate from Monday to Friday and during Morning and Afternoon peak hours. Vehicle restrictions are rotated annually in order to vary the use of vehicles with respect to the weekday. This measure has increased circulation speeds by 48%, and reduced gas consumption by 8%, and air pollution by 11% in the city.

Advantages

- Lower pollution and gas consumption
- Short term effectiveness
- Low cost of implementation

Disadvantages

- Difficulty in enforcing prohibition
- Increase in vehicle purchase as time passes (increase in vehicles limits the measure's effectiveness)
- Restraining the right to free mobilization
- Must go hand in hand with other measures and citizen culture campaign

3. Urban Tolls / Congestion Pricing Fee

A frequently used alternative to reducing traffic flow is the installation of toll plazas within the city. These toll plazas are typically placed on freeways, before, or in between cities. By implementing the toll in an urban area, road users can travel in their vehicles to access the area only if they are willing to pay the toll. Those who do not wish to pay the toll can take transit to reach their destinations.

In 1975, Singapore imposed a congestion pricing fare to travelers coming into the city in a private vehicle. First, it was charged during morning peak hours, and vehicles with special permits were exempt. However, to avoid the shift of congestion periods, the fare was applied to all vehicles and repeated throughout the day, resulting in more than 40% reduction in trips.

London, Oslo, Stockholm, Bergen, and Trondheim—all European cities—have also implemented the Congestion Pricing System. The measures has been successful in every city implemented.

London established the system in February 2003 to travelers entering the city. During the first year, vehicle flow was reduced by 30%, increasing the use of public transit options. The system makes use of cameras, strategically placed at the entry points of the urban center, which take pictures of the license plate as the vehicle enters or exits the zone. Later, the bill is mailed. The fee fluctuates depending on the time of entrance and is applied on weekdays only. *(continues on the next page)*

Traffic Management...

(continued from page 5)

Advantages

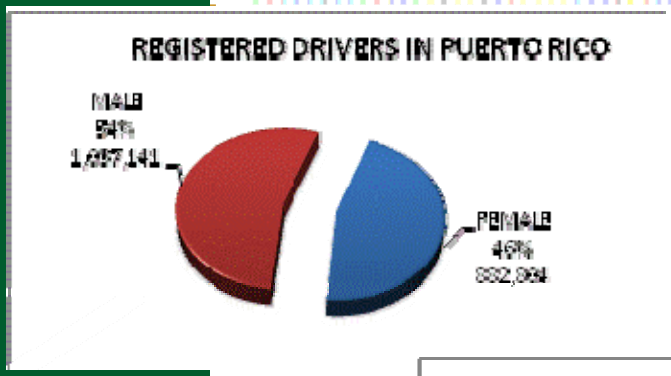
- Reduces vehicle flow, thus toxic gas emissions
- Source of funds for new transportation projects
- Available income for financing transit projects

Disadvantages

- Implementation of the system
- Need to educate the population
- Difficult to oversee
- May generate congestion before and after congestion fee period
- May diminish visits to the controlled zone
- May induce social exclusion (the affluent can use their vehicles)

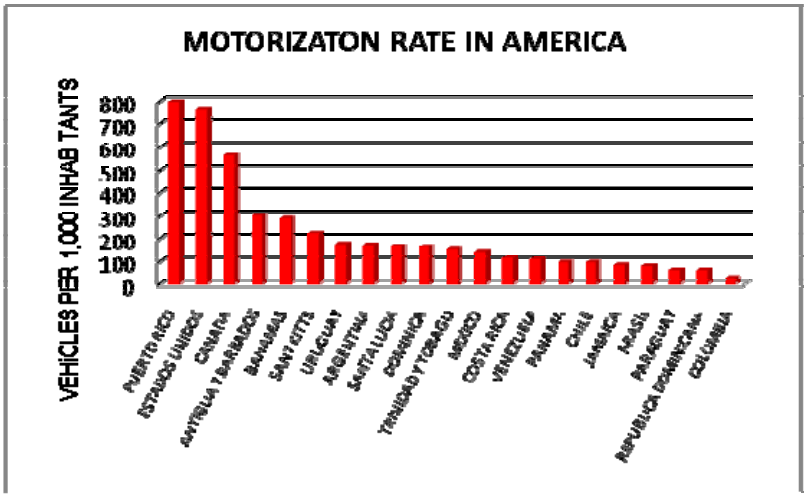
Other traffic management measures to control travel demand in a city are:

- Scattering employees' work schedule in order to minimize peak hour travel and distribute them throughout the day.
- Home based work plans where the employee visits the office once or twice a week.
- Implementing High Occupancy Lanes (HOV) exclusive for vehicles with high occupation
- Educational campaigns pointed at promoting carpool, and environmental awareness with the use of transit



Statistics in Puerto Rico: 2008

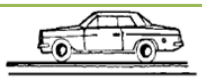
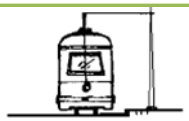
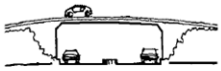
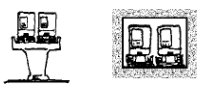
Authorized drivers: 2,023,444
Registered vehicles: 3,129,561
Estimated population: 3,926,638



Urban Transportation Development Strategies by City Growth

Urban transportation development must take in consideration the users' travel distances, the area's activity type, the place's morphology, and the needs and conditions of mobility, among other aspects. Urban strategies cover from local travel to regional or suburban displacement of the city's residents. The following strategies depend on transportation studies, government's financial and administrative capacity, and residents' culture toward transportation options.

Some of the following strategies can be used as elements of a Transit Oriented Development Plan (TOD) that uses transportation planning as a mean to increase development in a zone or city. These strategies can combine rail systems or buses, with pedestrian and mixed land uses for the sustainable development of residents.

Urban Strategy		Characteristics	Systems / Modes
Pedestrian		• Short distances • Interaction with the city	Pedestrians, cyclists
Private transportation		• Speed • Comfort and convenience • Long distances	Private motor vehicle
Rentals		• All public services • Cost is relative to distance • Works on a demand basis	Taxis
Broadening roads		• Increases capacity • Service level • Right-of-way availability	Arterials, avenue
Collective transportation		• Capacity and frequency • User pays fare • Comfortable vehicle	municipal trolleys, buses, "carros públicos"
Transit mall		• Excludes private vehicle • Commercial/pedestrian areas • Accessible	Pedestrian, cyclists, buses, light train, streetcar
Separation of transportation modes		• Reliable service • Capacity and frequency • Higher speed of transit services	Exclusive lanes for collective transportation, buses, light train, streetcar, bus-rapid transit
Guided transportation		• Capacity and frequency • Electric traction • Comfortable • Operational costs	Light train, streetcar
Separated right-of-way for private transportation		• Capacity • Speed • Security • Convenience	Viaduct, urban highway
Separated right-of-way for transit modes		• Capacity • Speed • Reliable • Area impact	Controlled services, heavy train, metro, people-movers

Modified from Vuchic (2007) Urban Transit, Systems and Technology.

Model for the Development...

(continued from page 1)

System Development

In 1986, the municipality of Carolina started running a public transportation system aimed at resolving the mobility problems of the city. The system developed from having three “trolley-type” buses in 1991, operating around Isla Verde, to having five buses in 1994, providing services to Isla Verde and the city’s urban center.

A significant development occurred in April 20, 1999, when the Urban *Municipal Transportation System* was opened; establishing a number of routes within the municipality’s urban center. The system was again expanded in July 1, 2008, with four new routes along the rural municipal zone and renaming it *Intermodal Transportation System of Carolina* (SITRAC by its acronym in Spanish). This system expansion provides mobility to over 35,000 residents.

Characteristics of SITRAC Operations

SITRAC is an intermodal transportation system that uses 8 routes to connect the urban city center with the rural areas, and service with “Públicos” where there are no bus routes. Nowadays, SITRAC has 4 rural and 4 urban routes.

SITRAC is free of charge to users. Trips that require transfer to rural routes in “Carros Públicos” need to pay a 25 cent fare. SITRAC provides services from Monday to Friday, from 6 AM to 6 PM, with an approximate 20 minute to 1 hour frequency depending on the route and period; with the last bus leaving at 5:30 PM. The system may extend its schedule when special institutional activities take place, in order to provide services to users who wish to attend.

The transportation system was set in place with funds from the 1998 -1999 municipal budget. These funds included operational, administrative, and equipment spending. Nowadays, the system is backed by federal funds from the Federal Transit Administration (FTA). All SITRAC operators are trained in fist aid, emergency management, and other skills. In addition, alcohol and drug test are required to all operators.

SITRAC Vehicles

Each bus has space for two wheelchairs and is equipped with special equipment to facilitate the access and exit of wheelchairs. Units are equipped with high capacity air conditioners and a digital video system which presents institutional information from the Municipality. In addition, buses contain a instructional sound system to provide information to passengers inside and outside the vehicle unit.

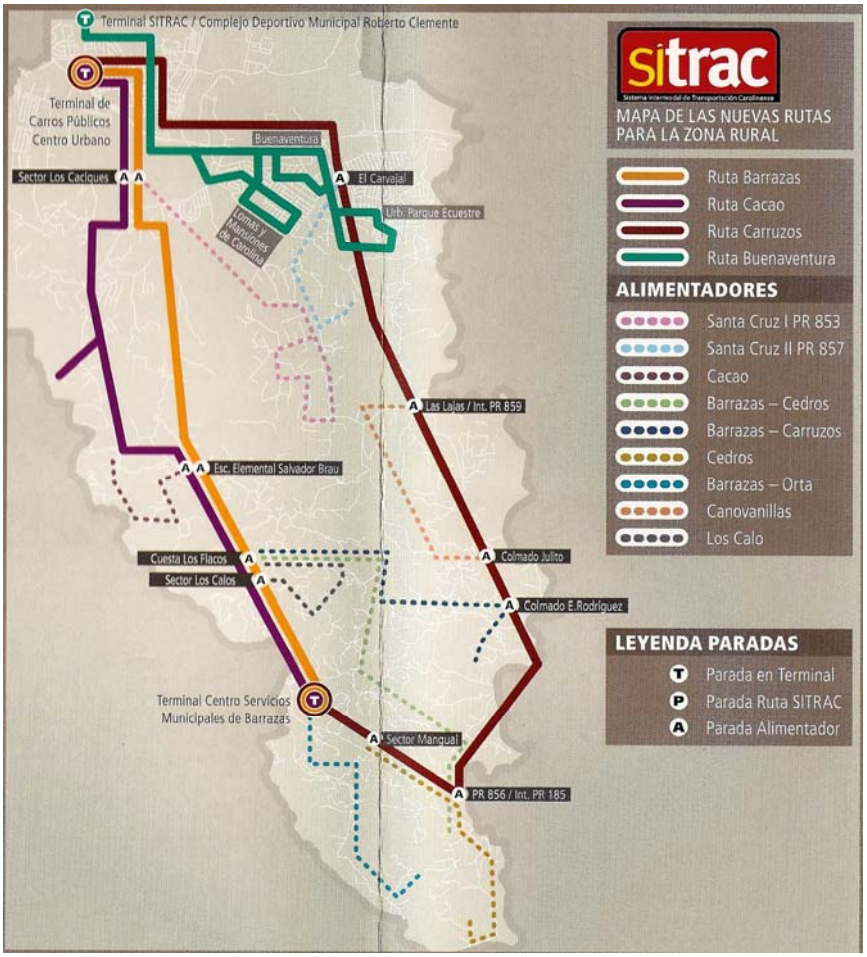
The system is composed of 19 units with a capacity of 26 seated passengers and 12 standing passengers. The system also operates a minibus, named SITRAC junior or SETUM with capacity for 11 passengers.

System Routes

SITRAC operates 8 routes with 122 stops distributed around the city's urban center, Isla Verde, and the rural areas. Routes take an approximate 30-35 minutes to complete an end-to-end trip. The longest run is the Carruzo route, with 40 minutes of end-to-end travel time. The system keeps control over the routes requiring the unit to report in every stop to the control station, called Control 8, the route's situation allowing the station to keep a travel log.

Urban Routes: The Red, Green, and Yellow routes provide services to the municipality's urban town center. The Orange route covers from the Isla Verde's Center for Municipal Services to the Carolina's public beach area.

Rural Routes: The four routes provide service to the most populated rural areas, Barrazas and Cacao. The Barrazas route operates from the Taxi Terminal in the town center to the terminal at the Center for Municipal Services in Barrazas, on the west side of the municipality. The Buenaventura route starts at the SITRAC terminal at the Roberto Clemente Sport Complex, covering Las Lomas, Mansiones de Carolina, and Ecuestre Park, circling back to the Sport Complex. The Carruzos route covers the east side of the municipality from the Taxi Terminal to Barrazas' Center for Municipal Services.



Feeder Routes and Demand Response Service

SITRAC is supported by "Carros Públicos" (porteadores públicos) and with permit from the Public Service Commission, the system's regulating body. The "Públicos" are an essential element to achieve the interconnection of the established SITRAC routes and hard-to-reach places for the buses, given their location or distance. Currently, 9 "Públicos" routes complete the municipality's four rural routes.

The "Públicos" operate from 5:30 AM to 6:00 PM, from Monday to Friday. This schedule is covered with two shifts, a 5:30 AM to 12:00 PM morning shift and a 12:00 PM to 6:00 PM afternoon shift. During peak hours service is offered every 30 minutes; at any other time, service is available every hour. Part of the

Model for the Development...

(continued from page 9)

agreement with the "Públicos" provides them with a monthly $800 stipend together with the 25 cent passenger fare; fare belonging to the driver.

Since November 2002 the municipality keeps a service contract with the Metropolitan Bus Authority (AMA) agreeing to provide complementary handicap service, through a paratransit program named Call and Travel, to people who need to travel outside municipal fringes. In addition, the Municipality, in compliance with the Americans with Disability Act, has implemented their own special transportation services for people with disabilities within municipal limits, developing their own user data base for those who are unable to use the fix routes because of disabilities.

Ridership and System Benefits

SITRAC has carry a total of 773,362 travelers with the eight fixed routes, special routes, and handicap services from July 1st, 2008 to May 31, 2009.

Although the Municipality does not receive direct income for the transportation services, benefits are reflected in a sense of belonging to residents and an increase in commercial activity within the Municipality. This economic activity generates an increase in municipal taxes from businesses and new housing projects, which allow mix use of the city's land and places served by the SITRAC.

Route	Ridership
Urban	
Green	158,412
Red	90,937
Orange (Isla Verde)	15,061
Yellow (Buenavista)	115,195
Rural	
Barrazas	77,759
Buenaventura	143,692
Cacao	56,556
Carruzos	93,412
Special Routes	22,276
Trips to Persons with Disabilities	62
Total	*773,362*

In addition, residents' transportation spending are cut when private vehicle dependency is reduced together with its well known environmental implications. SITRAC supports improving the quality of life for residents and tourists in Carolina; crating a fit and pleasant environment in a sustainable city.

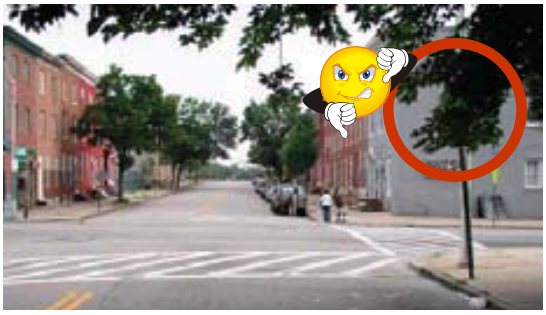
For information about SITRAC visit www.gmacpr.com or call (787) 701-4405 or 757-2626.

Our gratitude to the Autonomous Municipality of Carolina, Mayor José Carlos Aponte Dalmau, Mr. Victor Canales, Attorney José M. Díaz García, and Planner Betzaida Centeno Ramos.

Important Practices of Vegetation Control

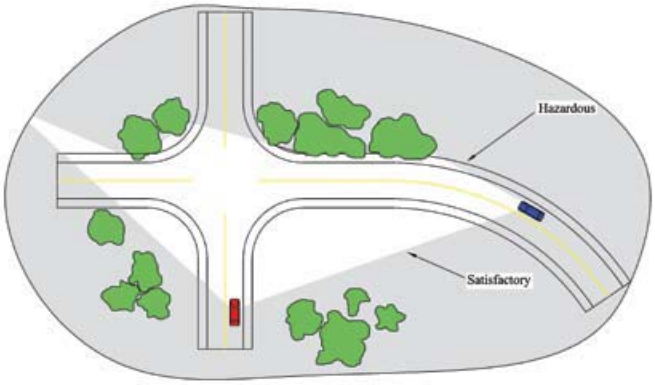
Source: FHWA Vegetation Control Guide

- **Sign visibility** - It is important that all users see all roadway signs, so blocking vegetation in front of signs should be trimmed as soon as possible.



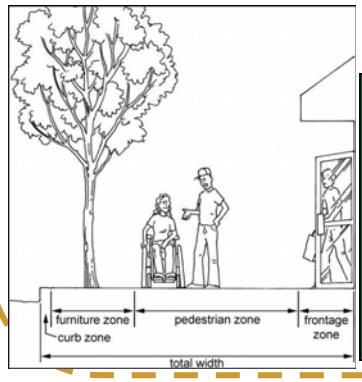
- **Clear sight lines** - Tall grass, weeds and brush in the shoulder, ditch, and backslope areas of a roadside can block the sight of hazards such as culvert headwalls, drainage inlets, guardrails, end treatments, and other fixed objects.

- **Maintain drainage** - Weeds, turf, and sod can interfere with roadside drainage. A high shoulder creates a secondary ditch that promote damage to the pavement and allows water on the surface that could create safety problems, such hydroplaning.



- **Side road and intersection visibility** - Safe and efficient vehicle movement through an intersection requires good visibility of traffic from all directions. A sight triangle at each corner of an intersection, free from obstructions, helps road users to avoid potential safety issues.

- **Presence of roadside trees** - Trees could be potential severe hazards depending on their size and location with respect to vehicle traffic. Isolated trees provide a better opportunity for removal based on its potential crash frequency and severity.



- **Pedestrian paths** - Must be completely free of overhanging and protruding vegetation. Objects must not protrude lower than a height of 80 inches, higher than 27 inches from the ground, and outward more than 4 inches from posts, buildings or free-standing fixtures. Another safety issue caused by vegetation is “changes in level” due to tree roots. This hazard causes pedestrians to trip and fall and also makes a walkway inaccessible to wheelchair users.

Future Seminars and Events

The Center will be presenting the following seminars:

Basic Concepts of Public Transportation

Date: October 30, 2009
Instructor: Dr. Felipe Luyanda
Place: Casa Capitular CIAPR, Ponce

Ethical Concepts in Engineering Practice

Date: November 19, 2009
Instructor: Dr. Francisco Maldonado
Place: Department of Public Works, Saint Croix, Islas Vírgenes

Practical Guidelines of Temporary Traffic Control in Transportation Related Activities and Nighttime Operations in Work Zones

Date: November 19-20, 2009
Instructor: Dr. Alberto Figueroa
Place: Department of Public Works, Saint Thomas, Islas Vírgenes

Ethical Concepts in Engineering Practice

Date: December 4, 2009
Instructor: Dr. Francisco Maldonado
Place: Department of Public Works Saint Thomas, Islas Vírgenes

Practical Guidelines of Temporary Traffic Control in Transportation Related Activities and Nighttime Operations in Work Zones

Date: December 17-18, 2009
Instructor: Dr. Benjamin Colucci
Place: Departamento de Obras Públicas, Saint Croix, Islas Vírgenes

For information about seminars and registration please contact: Ms. Grisel Villarrubia
Telephone: 787-834-6385
E-mail address: grisel.villarubia1@upr.edu
www.uprm.edu/prt2

International Conferences and Symposiums

Symposium on Public Transport and Special Events

International Association of Public Transport (UITP)
Date: November 12-13, 2009
Place: Recife, Brazil
http://www.uitp.org/

89th Annual Meeting of the Transportation Research Board

Date: January 10-14, 2010
Place: Marriott Wardman Park, Omni Shoreham and Hilton Washington, Washington, D.C.
http://www.trb.org/

Center News: UPRM Students Take Part in Exchange Program with the University of Rhode Island

The University of Rhode Island (URI) and the University of Puerto Rico at Mayagüez (UPRM) have a Collaboration Agreement since 2005 to promote instruction, research, and related activities in transportation. The partnership has served to institute a Summer Research and Exchange Program, with the assistance of the Federal Highway Administration Dwight D. Eisenhower Fellowship Program. The program is administered through the URI Transportation Center and the UPRM Transportation Technology Transfer Center.

UPRM students Jeannette Feliciano, Alvin Nieves, Máximo Polanco, and Liza Ríos, and URI students Colleen Grinham and Caitlyn Maleck participated in the Exchange Program during the Summer 2009. During the ten-week program, the students from each institution traveled to the other campus to work actively in transportation-related research studies. A faculty advisor is assigned to each student to provide guidance and assistance. At the end of the term, the students present their research findings and conclusions to faculty, students, and staff in both universities.

UPRM students Máximo Polanco, Jeannette Feliciano, Alvin Nieves, and Liza Rios, with Dr. Alberto M. Figueroa

URI faculty, staff and students, FHWA and RIDOT officials, and UPRM students at the Research Presentations Activity.

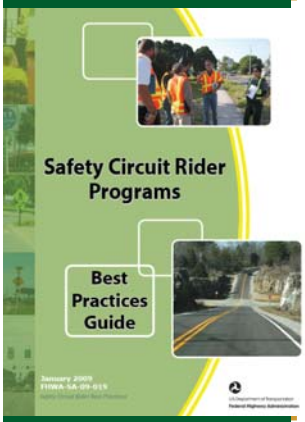
UPRM faculty and students and URI students at the Research Presentations Activity.

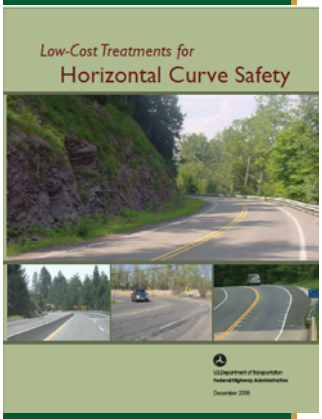
URI students Caitlyn Maleck and Coleen Grinham at the Final Program Activity at UPRM.

The UPRM-URI Summer Exchange Program is a successful model for the development of future professionals in the transportation field that merit to be expanded and replicated. In addition to acquire experience by conducting research as part of their education and training; the students in the Exchange Program benefit from being exposed to transportation issues in a different setting, environment, and culture. It allows students from both institutions to perceive directly the differences in the transportation systems and their users. This change in setting provides students with a entirely different new perspective that allows them to open their minds to analyze and evaluate issues in transportation in a global standpoint; an important aspect in the professional development of college students that cannot be reached solely in the classroom.

New Publications and Resources in our Library

Our Center has the following new audiovisual resources and publications, which are available for loan in our library.





PUBLICACIONS / REPORTS:

SAFETY CIRCUIT RIDER PROGRAMS: BEST PRACTICES GUIDES
Report FHWA-SA-09-019
Federal Highway Administration

TRIBAL ROAD SAFETY AUDIT: CASE STUDIES
Report FHWA-SA-08-005
Federal Highway Administration

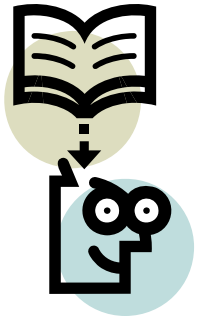
TRAFFIC ANALYSIS TOOLBOX VOLUME III: WORK ZONE MODELING AND SIMULATION—A GUIDE FOR DECISION MAKERS
Report FHWA-HOP-08-029
Federal Highway Administration

LOW COST TREATMENTS FOR HORIZONTAL CURVE SAFETY
Report FHWA-SA-07-002
Federal Highway Administration

FHWA ROAD SAFETY AUDIT GUIDELINES
Report FHWA-SA-06-06
Federal Highway Administration

GUIDE TO PROMOTING BICYCLING ON FEDERAL LANDS
Report FHWA-CFL/TD-08-007
Central Federal Lands Highway Division

GROUND-BASED LIDAR: ROCK SLOPE MAPPING AND ASSESSMENT
Report FHWA-CFL/TD-08-006
Central Federal Lands Highway Division



DVD VIDEO:

OPERATORS PRE-START MOTOR GRADER INSPECTION

Prepared by: TEEX, Local Technical Assistance Program

TRAINING PROGRAM CD:

ROADWAY SAFETY+ Versión 9.0
A Road Construction Industry Consortium Training Program

Prepared by:
U.S. Department of Transportation
Federal Highway Administration

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Message from the Editor of this Edition of El Puente, Dr. Alberto Figueroa

Puerto Rico has one of highest motorization rates worldwide. Our road system has been developed and oriented in the last 60 years towards the use of private vehicles, which coupled with our cities' suburbanization trend generates great vehicle flows in peak hours resulting in highly congested urban networks. Our geographical condition and the limited space reduces the potential for new roads or expanding the existing network capacity in order to fulfill present and future mobility needs. This situation requires innovative measures to diversify the transportation offer and control travel demand, particularly from private motor vehicles.

This edition of EL PUENTE presents information about vehicle demand control strategies that have been successfully put in place in different cities or countries that suffered from extreme vehicle congestion problems. Another article presents a review of the Carolina's SITRAC transportation system as an example of an Urban Municipal Transportation System development by diversifying the transportation offer in a local municipality.

The Center is grateful to Victor Uribe, Transportation Engineering doctoral student in the UPRM, for his special collaboration in writing these articles. I hope you enjoy this new edition.

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