Civil Engineering Studies
Transportation Engineering Series No. 149
Traffic Operations Lab Series No. 23

UILU-ENG-2007-2007

ISSN-0917-9191

Crosswalk Safety Study for UIUC Campus: Executive Summary

By
Rahim F. Benekohal
Juan C. Medina
Jarice D. Rodriguez
Ming-Heng Wang

A report published by
Traffic Operations Laboratory
Department of Civil and Environmental Engineering
University of Illinois at Urbana-Champaign

Prepared for
Office of Facilities and Services
University of Illinois at Urbana-Champaign

February 2007

Technical Report Documentation Page

1. Report No, FHWA-IL/UI-TOL-23	2. Government Accession No.	3. Recipient's Catalog No
4. Title and Subtitle Crosswalk Safety Study for UIUC Campus: Executive Summary		5. Report Date February 2007 6. Performing Organization Code
7. Author(s) R. F. Benekohal, J. C. Medina, J.D. Rodriguez, M-H Wang		8. Performing Organization Report No.
9. Performing Organization Name and Address Department of Civil and Environmental Enginee University of Illinois at Urbana-Champaign 205 N. Mathews Ave. Urbana, Illinois 61801		10. Work Unit (TRAIS) 11. Contract or Grant No. 13. Type of Report and Period Covered 2005-2007
12. Sponsoring Agency Name and Address Office of Facilities and Services University of Illinois at Urbana-Champaign		14. Sponsoring Agency Code
15. Supplementary		

16. Abstract

The University of Illinois at Urbana-Champaign has used in-street pedestrian crossing signs and in-roadway warning lights to improve pedestrian safety. A comprehensive study of crosswalk safety was conducted to determine the effectiveness of the signs and to make suggestions to improve crosswalk safety. This study had four main components: opinion surveys, focus group meetings, pedestrian-vehicle conflicts in crosswalks, and visits to Big Ten University campuses. In two campus-wide web-based surveys, nearly 12,000 pedestrians and drivers participated. More than 95% of the participants provided valid surveys and about 70% of them wrote comments and suggestions. There were 11 focus group meetings with over 70 participants from various groups interested in campus traffic safety. Field data on pedestrian-vehicle interactions and conflicts at 24 crosswalks were collected and analyzed. The research team members visited all Big Ten University Campuses to learn about their current and future plans for improving crosswalk safety. This document summarizes the major findings and recommendations of this study. The complete set of analyses and results can be found in the following four individual reports:

- Analysis of Pedestrians and Drivers Opinions on Crosswalk Safety at UIUC Campus. Volume 1: Pedestrian and Driver Surveys
- Analysis of Pedestrians and Drivers Opinions on Crosswalk Safety at UIUC Campus. Volume 2: Participants' Comments and Suggestions
- Pedestrian Safety on Campus Crosswalks in Big Ten Universities
- Crosswalk Signing and Marking Effects on Conflicts and Pedestrian Safety in UIUC Campus

17. Key Words Campus crosswalk, pedestrian crosswalk safety, pedestrian driver opinion survey, in-street crossing sign, in-roadway warning light, traffic safety, pedestrian-vehicle conflict.	18. Distribution Statement		
19. Security Classif. (of this report) Unclassified	20. Security Classif. (of this page) Unclassified	21. No. of Pages 13	22. Price

`Form DOT F 1700.7 (8-72)

Reproduction of completed page authorized

Acknowledgment and Disclaimer

The authors would like to thank Ms. Pamela Voitik of the University of Illinois for her suggestions, comments and cooperation throughout this study.

This report is published by the Traffic Operations Laboratory (TOL) at the University of Illinois at Urbana-Champaign. The contents of this report reflect the views of the authors, who are responsible for the facts and accuracy of the data presented herein. The contents do not reflect the official views or policies of IDOT, FHWA, or the University of Illinois. This report does not constitute a standard, specification, or regulation.

Executive Summary

This study had four main components: opinion surveys *(1,2)*, focus group meetings *(2)*, pedestrian-vehicle conflicts in crosswalks *(3)*, and visits to Big Ten University campuses *(4)*. In a campus-wide, web-based survey of pedestrians' opinions, 7046 pedestrians, and in a similar survey of drivers' opinions, 4813 drivers participated. Not only more than 95% of the participants provided valid surveys, but also, about 70% of them provided comments and suggestions as well. There were 11 focus group meetings with over 70 participants from various groups interested in campus traffic safety. Field data on pedestrian-vehicle interactions and conflicts at 24 crosswalks were collected and analyzed. The research team members visited all Big Ten University Campuses to learn about their current and future plans for crosswalk safety. This Executive Summary has 6 sections and summarizes the findings and recommendations of four individual reports prepared for this study.

A. GENERAL ISSUES

Pedestrians are concerned with motorist and bus driver behavior at crosswalks, as are motorists concerned with pedestrian behavior at crosswalks. Pedestrians considered approximately half of the motorists and one-third of the bus driver behavior to be careless toward them. On the other hand, over half of the motorists believe that pedestrians are "very careless" when crossing campus streets. The most frequent comments and suggestions by both pedestrians and motorists were related to enforcement and education. The second most frequent topic for both pedestrians and motorists was intersection and crosswalk safety.

An overwhelming majority of the lead pedestrians observed, at least 93% at midblock and 97% at intersection crosswalks, looked both directions before crossing the streets. The rest either looked at one direction only, or it was not clear if they looked at all. However, even this small fraction can still create plenty of opportunity for accidents to happen in crosswalks. Education and enforcement efforts are needed to minimize the risk taken by the small fraction of pedestrians who do not look both ways before crossing.

All Big Ten Universities have individuals managing traffic safety on their campuses, however the universities that have designated individual(s) whose main responsibility is to deal with campus transportation issues and traffic safety, have better coordination and more focused pedestrian safety programs. For instance, Michigan State University has a university traffic engineer who is also a faculty member, the University of Wisconsin at Madison has a bike and pedestrian coordinator and a senior transportation planner, the University of Minnesota has a bike coordinator to work with pedestrian and bicycle safety

issues, and the University of Iowa has a half-time transportation modes coordinator in charge of issues related to pedestrians and bicycles.

Also all Big Ten Universities are taking steps to provide a pedestrian and bicycle friendly environment. Several universities have planned to improve bike routes, construct pedestrian zones, add countdown signals for pedestrians, install traffic signals due to pedestrian needs, and coordinate location of building entrances with crosswalks. Purdue even has a plan to relocate a state route that goes through the campus to reduce through traffic.

It is recommended to:

1. Install conspicuous and attention-grabbing signs at main vehicular entrances to campus to alert motorists to yield to pedestrians and drive defensively.

2. Design the intersection and midblock crosswalks on campus with distinct features to continuously remind motorists that they are in a campus district and high-pedestrian area. For example, a distinct feature might be using brick-like texture on crosswalks with a contrasting color to help improve crosswalk visibility.

3. Conduct a study to determine the feasibility of closing some streets to vehicular traffic in the core area of the campus and converting them to pedestrian friendly zones.

4. Designate/hire a person as a full-time campus transportation coordinator whose main responsibility would be transportation and traffic safety issues on campus.

5. Establish a campus traffic safety committee with a diverse group of participants to discuss traffic safety and advise the campus administration on these issues.

6. Develop short-term and long-term transportation and traffic safety plans for the campus.

.

7. Coordinate building entrances and pedestrian paths with crosswalk locations to reduce crossing at unmarked locations.

B. EDUCATION AND ENFORCEMENT

The most frequently mentioned comments in the surveys were related to education and enforcement. Pedestrians are more inclined toward education than enforcement, and support education for both pedestrians and motorists, with

more emphasis on the pedestrians. Some pedestrians are concerned about aggressive driving, particularly bus drivers, toward pedestrians at crosswalks. On the other hand, motorists are more in favor of enforcement of laws for pedestrians. The focus group participants also concurred that pedestrian education is one of the primary issues of pedestrian safety on campus.

All Big Ten Universities have traffic law enforcement programs, but only Purdue issues jaywalking tickets. All the universities provided pedestrian safety tips during their freshman orientation and a few of them dedicated additional efforts to address pedestrian safety.

It is recommended to:

1. Conduct an educational campaign for all campus users with more focus on students, explaining the correct meaning and use of the in-street pedestrian signs, pedestrian signals at intersections, proper use of crosswalks, bicycles, automobiles and buses on campus.

2. Allocate specific times during freshmen, international student, and new employee orientations to promote campus traffic safety.

3. Make periodic public announcements on the distractive nature of audible devices or cellular phones and encourage people to be more careful in crosswalks. Make pedestrian safety announcements during sport, cultural, educational, and entertainment events.

4. Explore the feasibility of making pedestrian safety part of the CARE program or offer a similar mandatory class/seminar, and roundtable discussions.

5. Distribute campus traffic safety flyers, CD/DVD, and brochures in residence halls, sorority and fraternity houses, student activity centers, and locations with high pedestrian and vehicle volumes. Distribute maps with recommended walking areas and bike routes.

6. Promote pedestrian safety through the University websites, printed posters, etc.

7. Create bike/pedestrian safety class programs, where bicyclists learn the “bicycle rules of the road”. Bicyclists could avoid paying ticket fines by attending safety classes.

8. Create a pedestrian/bike patrol program where students are hired to monitor and promote bicycle and pedestrian safety.

9. Enforce speeding and other traffic laws on a regular basis. Issue tickets to motorists who do not yield to pedestrians in crosswalks or block pedestrian walkways. Enforce proper use of loading and unloading areas on campus.

10. Require the Champaign-Urbana Mass Transit District (MTD) to provide and publicize an open phone line to report on unsatisfactory drivers. Also require that bus drivers not talk on the phone while driving.

C. SIGNALS, MARKINGS AND VISIBILITY

Pedestrian signals at intersections (walk/don't walk) have a positive effect in directing pedestrian traffic, but there is some confusion, particularly with the flashing don't walk signal and all-pedestrian phase (exclusive pedestrian phase). Pedestrians prefer more countdowns signals at intersections with heavy pedestrian volume and better timing of the exclusive pedestrian phase (such as Wright and Green).

The countdown signals are not helpful for blind pedestrians if they are not equipped with audible pedestrian signals (APS). Some of the current APS were said to be difficult to locate due to high street noise levels. Mobility of pedestrians with disabilities can be improved by properly designing intersections and cutting the curbs. At some locations, curb cuts are nonexistent and at others they are not properly aligned with the crosswalk. Besides the curb cuts, visually impaired pedestrians suggested the use of audible signs at all sidewalk closures due to temporary construction or maintenance work.

Pedestrians and motorists are also concerned about street lighting. The visibility of crosswalks at night should be improved by providing better street lighting around crosswalks. Adequate lighting is very important in reducing the potential for conflicts between vehicles and pedestrians.

It is recommended to:

1. Place small plates next to pedestrian signal push buttons at busy intersections to tell the meanings of walk/don't walk signals.

2. Improve pedestrian signal timings at Sixth St and Green St as well as Green St and Wright St so that adequate time for the pedestrian phase is provided and diagonal crosswalk marking is placed on pavement to communicate with pedestrians that diagonal crossing is allowed at those locations.

3. Make crosswalks more visible to both pedestrians and motorists by painting them regularly or by creating color and/or texture contrast,

increasing users' awareness and utilization of crosswalks. A brick-like textured crosswalk with a contrasting color to increase crosswalk visibility is recommended.

4. To improve mobility of visually impaired pedestrians, align curb cuts with crosswalks at all crosswalk locations and at busy intersections, install audible pedestrian signals.

5. Restrict on street parking that is too close to intersection or mid-block crosswalks to improve the visibility of pedestrians.

6. Install pedestrian-activated signals at busy midblock crossings to allow pedestrians to cross when vehicles are stopped.

7. Encourage the use of crosswalks by installing visually appealing barriers such as bushes or fences, with openings only at marked crosswalks for pedestrians to cross the street.

8. Consider upgrading to more restrictive control devices (such as changing two-way stops to four-way stop, or four-way stops to signalized intersections) at intersections with a high number of conflicts.

9. Install refuge islands on multilane crossings with high traffic volume or high pedestrian volume.

10. Properly install crosswalks at locations that pedestrians have gradually transformed into de facto crosswalks, unless corrective measures are taken to prevent them from crossing at these locations.

11. Regularly repaint campus crosswalks before they fade away to the point that they are no longer noticeable.

12. Provide street lighting at or near crosswalks to improve the visibility of pedestrians at night. Adequate visibility is important in reducing potential conflicts between vehicles and pedestrians. Improvements to street lighting are recommended specially for "darker" campus streets such as 4th St and 1st St south of Green St.

D. CROSSWALK SIGNS

Pedestrians and motorists felt safer at crosswalks with in-street pedestrian signs compared to crosswalks without such signs. However, about half of both pedestrians and motorists correctly understood the meaning of the signs and the other half misinterpreted them to various degrees. The misinterpretation created a false sense of security for some pedestrians. The proportion of participants

who misinterpret the sign is higher among students compared to faculty and staff, and it is also higher for people who ride the bus compared to those who walk or drive on campus. The use of the signs was widely supported by pedestrians; however, motorists had mixed opinions and were more inclined toward removing the signs or replacing them with a stop sign. Some motorists believe the yield-to-pedestrian signs give pedestrians a false sense of security when crossing the street.

Five different crosswalk signing treatments were observed on campus. The in-street yield-to-pedestrian sign plus in-roadway warning lights, used at the crosswalk in front of the Grainger Library, provided the highest courtesy yields (a courtesy yield occurs when a motorist yields to pedestrian, but the yield was not required). About 10% of motorists were required to yield and 95% of them complied (a required yield occur when a pedestrian steps into the crosswalk, while a vehicle is at a distance sufficient enough to slow down or stop, causing the driver to yield without creating a conflict with the pedestrian) .Even though this location had the lowest conflict rates, there were still 4.8 pedestrians per hour in conflict with vehicles. Traffic flow was disrupted here the most compared to other crosswalk treatments, and at times queue extended much beyond the crosswalk due to motorists waiting to find gaps in the steady stream of pedestrian traffic.

Another treatment, used at several crosswalks, is the in-street pedestrian crossing signs (without in-roadway lighting) which resulted in the highest proportion of motorists required to yield (22% for intersections and 19% for midblocks). However, on average 5% of motorists at midblock and 10% at intersection crosswalks did not comply with the required yield. The signs resulted in up to 6% and 8% courtesy yields at intersection and midblock crosswalks, respectively. It should be noted that some of the sign benefits may be reduced when pedestrian volume is so high that long queues are created and motorist delay is substantially increased, increasing motorists' frustration and willingness to engage in conflict with pedestrians.

The in-street signs did not discourage pedestrians from looking both directions before crossing, thus they did not encourage inattentive behavior. On the other hand, the signs increased the proportion of pedestrians who are willing to step into the crosswalk and make approaching vehicles yield (false sense of security). Considering that about 5-10% of the motorists did not comply with the required yield, in combination with pedestrians who rely on the motorists to yield, very high risk situations can be created.

The third treatment is the yield-here-to-pedestrian sign mounted on a post in the curb which provided similar but slightly lower benefits than the in-street signs. Conflict rates are slightly higher than those for in-street signs and comparable to marked crosswalks. Since the signs are not in the middle of the road, a lower percentage of pedestrians stepped into the crosswalk hoping that motorists

would yield for them. Thus, the false sense of security was lower with these signs compared to in-street signs. The curb signs do not need regular replacement due to vehicle hits and are not hindrances in snow removal.

The fourth treatment is marked crosswalks which had lower percentages of motorists required to yield and the compliance rate was also lower compared to the in-street signs and the yield-here-to-pedestrian signs. The yield compliance rate was lower at four-lane streets compared to two-lane streets. The courtesy yield was very low compared to other treatments. Most of the pedestrians waited for a gap in traffic to cross the street. For example, on Wright St at Daniel St, about 70% of the pedestrians who interacted with vehicles needed to wait at the curb for traffic to clear the road, even though vehicular volume (mostly buses) was low.

The fifth treatment is locations that are not marked as crosswalk but function that way. The proportion of motorists required to yield at unmarked crosswalks was the lowest of all treatments, and three out of four motorists did not comply with the yield. Most pedestrians wait for gaps in traffic to cross the street and they do not rely on motorists yielding them. There were almost no courtesy yields. Motorists do not expect pedestrians crossing at unmarked locations. When a location becomes a de facto crosswalk, it should be considered for marked as a crosswalk to improve yielding rates and reduce conflicts.

It is recommended to:

1. Install yield-here-to-pedestrian signs (on the curb) complemented with pedestrian activated in-roadway flashing lights, only at midblock crosswalks with a very high number of pedestrian-vehicle conflicts (similar to Grainger Library crosswalk).

2. Refrain from installing in-street pedestrian crossing signs (yield-to-pedestrian or stop-for-pedestrians) at midblock crosswalks, other than in exceptional conditions, due to the false sense of security coming from the misinterpretation of the signs. Instead, consider using yield-here-to-pedestrian signs mounted on the curb. The existing in-street signs may be replaced with yield-here-to-pedestrian signs placed on the curb. If the existing in-street signs are kept, then an educational campaign is recommended to improve understanding of the in-street signs.

3. Install in-street pedestrian crossing signs (yield-to-pedestrian or stop-for-pedestrians) at intersection crosswalks only under exceptional conditions due to the false sense of security coming from the misinterpretation of these signs. Instead, consider using the curb-mounted Pedestrian Warning Sign (W11-2) with downward pointing arrow plaque (W16-7p), preferably with fluorescent yellow-green background. The existing in-street signs may be replaced with the suggested Pedestrian Warning Sign. If the

existing in-street signs are kept, then an educational campaign is recommended to improve understanding of the in-street signs.

4. Refrain from mounting the current in-street pedestrian signs on the curb because the size and shape of the in-street signs is not appropriate for post-mounting, as it has been stated by the USDOT.

5. Utilize yield-here-to-pedestrian signs mounted on the curb instead of in-street yield to pedestrian signs, when possible, to reduce the false sense of security created by the in-street signs.

6. Use fluorescent yellow-green background color with black legend on all pedestrian signs. This would require the update of old standard yellow signs in order to keep uniformity throughout the campus.

7. Provide midblock crosswalks at locations where walkways cross streets and pedestrians regularly use the walkways. Pedestrians should be channelized to crosswalks by median or sidewalk barriers that are visually appealing and improve aesthetics of the area (such as low fences, flowers and bushes, and raised medians with plants).

E. BROADER TRANSPORTATION ISSUES

Traffic flow pattern on campus is not intuitive. Motorists (particularly unfamiliar ones) while driving on campus, try to navigate through rather complicated paths. This may create more conflicts with pedestrian. Pedestrians and motorists are in favor of reducing or banning vehicles (cars and buses) in the core campus area. Participants in the focus groups also made similar suggestions. Furthermore, some Big Ten campuses have taken actions to reduce traffic near or around the core to create pedestrian zones. In all campuses, except Indiana, Minnesota, and Iowa, the parking permits are restricted for freshman and students living at residence halls. Also, Big Ten campuses, except Northwestern University have used bus pullouts to prevent buses from blocking the roadway and vehicles from trying to pass stopped buses. Michigan State University is in the process of removing all bus pullouts. Reducing the speed limit on campus to improve pedestrian safety was mentioned by some pedestrians and motorists. However, speed enforcement on a regular basis on campus would slow down traffic, given that the current university district speed limit is already low.

Pedestrians have more conflicts with bikes than motor vehicles. Non-continuous or not well designed or maintained bike paths may encourage people to ride on sidewalks, creating conflicts with pedestrians. While experienced bicyclists prefer the bike lanes to be on the streets, sharing the road with other vehicles, less experienced bicyclists may prefer exclusive paths. At some university campuses

there is a combination of shared on-street paths and exclusive bike paths. It is desirable to have separate paths for pedestrians, bikes, and vehicles. However, at places where this is not possible, or at intersecting points, it is very important to properly warn the users about possible conflicts. Some university campuses have installed yield and stop signs for bikes at locations where bike lanes intersect with sidewalks or pedestrians paths.

It is recommended to:

1. Divert through traffic, commercial vehicles, and transit buses that do not have to be on campus streets to major streets on the periphery of campus.

2. Study a redesign of the current combination of two-way and one-way streets to reduce the number of vehicles looping in the core campus, and make traffic flow pattern, particularly in the core campus area, straightforward and intuitive.

3. To reduce speed, use traffic calming techniques such as speed humps, raised intersections with textured pavement at high-volume pedestrian zones, lane reduction markings, and curb extensions at crosswalks.

4. Revise and optimize bus routes and bus frequencies, to reduce rushing to meet the schedules and to reduce the number of areas where buses have greater conflict with pedestrians.

5. Consider the creation of a pedestrian zone in the core campus area with limited motor vehicle access.

6. Determine the location of bus stops considering the location of crosswalks, bike paths, pedestrian flow, vehicular flow, and visibility for both motorists and pedestrians.

7. Carefully examine the frequency and routing of the MTD buses to meet the transportation needs of bus riders and to minimize bus conflicts with pedestrians.

8. Avoid putting bus routes through minor streets and uncontrolled intersections where buses have to find gaps in the vehicular and pedestrian streams to cross the street or make a turn.

9. Mark bus stops with appropriate signs and request bus drivers to stop only at designated bus stops.

10. Coordinate the location of bus stops and crosswalks. Put the bus stops on four-lane streets after crosswalks so pedestrians walk behind the bus and

are more visible to oncoming traffic. On two-lane streets put the bus stops right before the crosswalk.

11. Require the bus drivers to be trained on driving in the campus environment. Also require more experienced and less aggressive bus drivers be assigned to campus routes because the routes are more demanding than regular bus routes and there is a very large population of young pedestrians.

12. Remove on-street parking spaces (1-2 spaces) to improve pedestrian visibility where parked vehicles are too close to crosswalks.

13. Promote remote parking and encourage motorists to walk or take a shuttle bus to the central part of the campus.

14. Study the feasibility of providing short term parking spaces within walking distance of major campus destinations/businesses to reduce circulating traffic looking for a parking space.

15. Improve bike paths and their continuity to reduce conflicts between bicyclist and pedestrians.

16. Provide adequate bicycle parking racks that are conveniently located.

17. Mark and sign the bike paths to adequately separate pedestrian and bike traffic, and to provide necessary alerts at bike path/crosswalk conflict points. Also, educate bicyclists on proper use of available bike facilities on campus.

18. Provide both on-street and off-street bike paths to accommodate the needs of all bike users. Experienced bicyclists prefer the bike path to be on the streets, but novice bike users feel more comfortable when it is off the road.

19. Promote education campaigns for bicyclists on the use of the bike paths and study the use of enforcement to increase compliance with the rules.

F. HIGH RISK LOCATIONS

High-risk intersections were identified based on pedestrian and motorist experiences with near hit crashes, crashes, and most avoided or least safe intersections. It should be noted that crash statistics are not expected to match those from the UI Police Department or the Illinois Department of Transportation because respondents represent a sample of the total population, and some of

non-injury crashes may not be reported. Based on these criteria, the following intersections were identified as the top high-risk locations, with most of them in the top 10 near misses for both pedestrian and driver surveys:

- Green St and Wright St
- Green St and Goodwin Ave
- Green St and Sixth St
- Green St and Fourth St
- Fourth St and Daniel St
- Fourth St and John St
- Fourth St and Chalmers St
- Fourth St and Armory St
- Sixth St and Chalmers St
- Nevada St and Lincoln Ave
- Illinois St and Goodwin Ave

High-risk midblock crosswalks were identified in the same way as the intersections, with the following locations considered high-risk:

- Green St between Wright St and Matthews Ave (in front of Illini Union)
- Springfield Ave between Wright St and Matthews Ave (in front of Grainger Library)
- Pennsylvania Ave between Fourth St and Sixth St
- All midblocks on Fourth St between Green St and Gregory Dr (identified mainly by motorists)
- All midblocks on Green St between Fourth St and Wright St (identified mainly by motorists)

It should be noted that there is only one marked midblock crosswalk on Fourth St (between Armory St and Gregory Dr) and none on Green St between Fourth St and Wright St, but pedestrians seem to cross Fourth St and Green St at these midblocks, causing concerns for motorists.

The locations mentioned above just indicate highest frequency from all locations identified by pedestrians and motorists. Comprehensive lists of high risk locations from both pedestrians' and motorists' opinions are provided in the report "Analysis of Pedestrians and Drivers Opinions on Crosswalk Safety at UIUC Campus - Volume 1: Pedestrian and Driver Surveys".

It is recommended to:

1. Consider the top least-safe intersection and midblock locations as candidates for near future pedestrian safety improvements.

2. Utilize various traffic calming techniques to reduce frequency and/or severity of conflicts between pedestrian and vehicles. Such techniques

include narrowing the width of streets at intersection and midblock crosswalks and use of speed bumps or speed humps to keep traffic from speeding.

References

1. Medina, J., Benekohal, R., Wang M.H. Analysis of Pedestrians and Drivers Opinions on Crosswalk Safety at UIUC Campus. Volume 1: Pedestrian and Driver Surveys. Traffic Operations Lab Series No.19. FHWA-IL/UI-TOL-19. University of Illinois at Urbana-Champaign. 2007.
2. Benekohal, R., Medina, J., Roberts, C., Moroni, K., Wingo, L. Analysis of Pedestrians and Drivers Opinions on Crosswalk Safety at UIUC Campus. Volume 2: Participants' Comments and Suggestions. Traffic Operations Lab Series No.20. FHWA-IL/UI-TOL-20. University of Illinois at Urbana-Champaign. 2007.
3. Benekohal, R., Wang, M-H, Medina, J., Crosswalk Signing and Marking Effects on Conflicts and Pedestrian Safety in UIUC Campus. Traffic Operations Lab Series No.22. FHWA-IL/UI-TOL-22. University of Illinois at Urbana-Champaign. 2007.
4. Rodriguez, J.D., Medina, J., Benekohal, R., Morocoima-Black R., Wang, M.H. Pedestrian Safety on Campus Crosswalks in Big Ten Universities. Traffic Operations Lab Series No.21. FHWA-IL/UI-TOL-21. University of Illinois at Urbana-Champaign. 2007.