



Indiana LTAP



Traffic Safety Primer for Local Agencies

Common Traffic Engineering Acronyms

AADT/ADT: Annual Average Daily Traffic / Average Daily Traffic

ADA: Americans with Disability Act

ARIES: Indiana's statewide crash database

FARS: Fatality Analysis Reporting System

FHWA: Federal Highway Administration

GIS: Geographic Information System

GPS: Global Positioning System

HAT: Hazard Analysis Tool

HCM: Highway Capacity Manual

HSAC: Highway Safety Advisory Council

HSIP: Highway Safety Improvement Program

HSM: Highway Safety Manual

ICJI: Indiana Criminal Justice Institute

IMUTCD: Indiana Manual on Uniform Traffic Control Devices

INDOT: Indiana Department of Transportation

ITS: Intelligent Transportation System

LOS: Level of Service

LPA: Local Public Agency

LRS: Linear Referencing System

LTAP: Local Technical Assistance Program

MAP 21: Moving Ahead for Progress in the 21st Century

MPO: Metropolitan Planning Organization

MUTCD: Manual on Uniform Traffic Control Devices

NHTSA: National Highway Traffic Safety Administration

PED: Pedestrian

PDO: Property Damage Only crash

ROW or R/W: Right-of-way

RPC: Regional Planning Commission

RSA: Road Safety Audit

SHSP: Strategic Highway Safety Plan

SRTS: Safe Routes to School

TAP: Transportation Alternatives Program

VPD: Vehicles Per Day

VMT: Vehicle Miles Traveled

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Adapted by permission from the Michigan LTAP's 2008 Publication *What Elected Officials Need to Know About Traffic Safety (And What YOUR Constituents Expect YOU to Know!)*

Decision Makers

On a daily basis, local agency personnel are forced to make numerous decisions that can have significant impact on the community they represent. The public expects their elected officials and street/highway department personnel to collect information, weigh the consequences and make the best decisions for their community. Because of the broad nature of decisions that local agency personnel face, they may find themselves working in areas outside their comfort zone. Traffic safety is likely one of those areas. To further complicate the issue, some aspects of traffic safety can encourage confusion, such as:

- **Counter-intuitive nature:** Many traffic safety decisions are counterintuitive. For example, installing a stop sign to control vehicle speed can actually *increase* vehicle speeds as drivers accelerate to “make up” lost time. There are more effective ways to control vehicle speeds, discussed later in this booklet.
- **Roads viewed as “commonplace”:** The public has come to view roads as an ordinary, simple feature of the landscape. This desensitization to the subtle design features of a road and the complex relationships that exist within roadway infrastructure lead to the belief that good, safe roads are “simple.”
- **Roads are a public asset:** The vast majority of roads are in the public trust. Because of this, many people feel that they have an interest in deciding the operation and function of roads in their community, which is true to an extent. However, when the general public begins to dictate design and operation factors without an understanding of their impact, the chance is high that there will be negative consequences to safety. It is also important to remember that public roads exist for all users and decisions should consider all users, whether that user is on foot, on a bike, in a buggy, in a bus, or in a car.

Empowerment

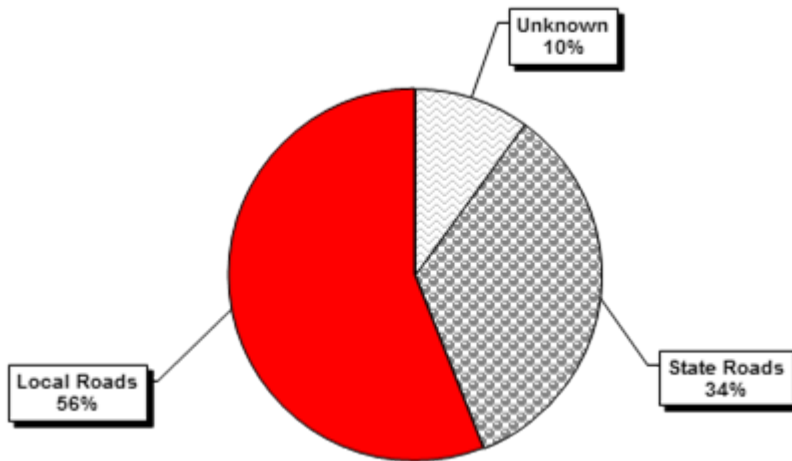
The purpose of this booklet is to empower local agency personnel to make informed decisions that can improve roadway safety in your community. By identifying and addressing potential roadway hazards, you can reduce the likelihood of a future traffic crash for your community and your family.

Achieving safer roads isn't mysterious or overly difficult. A good start to traffic safety planning and practice can occur when local agency officials focus on how they or their loved ones would react when encountering safety risks on their local roads. Also take into consideration increasing volumes of vehicles, walkers, and bicyclists lead to increased conflicts between vehicles and other users. Warning devices, traffic controls and access polices that weren't needed before may become valuable additions over time. It's a good practice to periodically ask yourself where warning devices are needed most and how can they best be maintained.

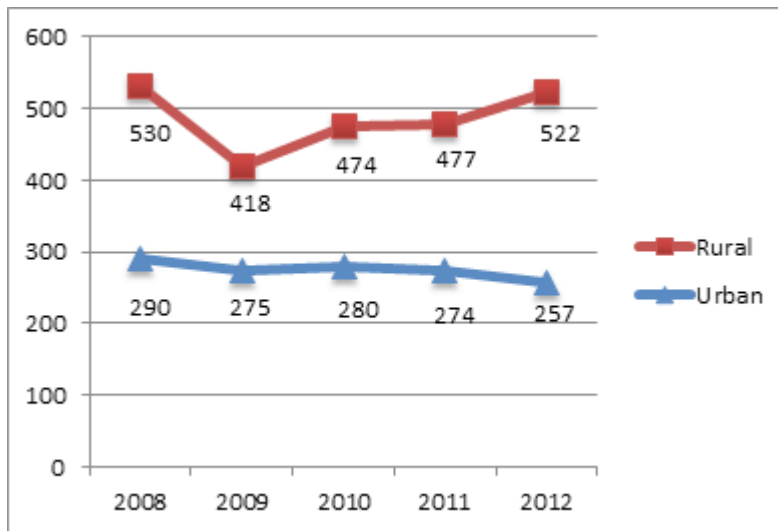
Where Do Most Crashes Occur in Indiana?

The majority of crashes occur on roads owned and maintained by Indiana’s local governments (cities, counties and towns). The majority of fatalities occur in rural areas, due to the higher speed roadways and increased distance to emergency trauma care.

CRASHES BY ROAD OWNERSHIP



FATALITIES BY LOCATION



Resources

- ◆ Indiana Crash Facts: Annual Reports Detailing the Crash Experience on Indiana’s Public Roads. <http://www.in.gov/cji/2367.htm>
- ◆ National Highway Traffic Safety Administration (safety reports and materials on a variety of national traffic safety subjects). <http://www.nhtsa.dot.gov>

Factors That May Contribute to the Number of Crashes on Local Roads

- **Lane width:** State highways and freeways typically have wider lanes than the local roads. In addition, many of these higher “functional class” roads also have wide paved shoulders. Research has shown that wider lanes and shoulders result in a decrease in the number of crashes, but may also lead to an increase in speeds—a different problem.
- **Curve and grade geometry:** Contrary to state highways and freeways, local roads generally have more locations where sharper curves and steeper grades exist because the cost of correcting the geometric problem may not be feasible based on the number of vehicles that use the road.
- **Signing and striping:** Generally speaking, local agencies do not have the budgets necessary to maintain signs and pavement markings on local roads to the same level as higher functional class roads. Poor pavement markings and a lack of signing can influence the number of crashes that occur.
- **Roadside Obstructions:** Higher functional class roadways (freeways and highways) typically have a wide, relatively flat, clear area outside the driving lanes where drivers who run off the road can recover and get their vehicle back on the road or stop without causing a traffic crash. It is not uncommon for local roads to have little if any recovery area or to have obstructions directly adjacent to travel lanes.
- **Number of driveways:** Research has shown that an increase in the number of crashes comes with an increasing number of driveways. Local roads are primarily for local property access, and as such, have a significant number of driveways. Higher functional class roads typically do not have as many driveways or have active “access management” programs to control driveway access.

Factors That Influence the Number of Crashes – All Roads

The interaction between the driver and the road is a complicated one, with decisions made constantly and sometimes subconsciously. It is fairly easy to make a mistake on the road, even for the seasoned driver. That momentary lapse in judgment, no matter how small, can lead to a crash. Crashes rarely have one single cause, however. Three factors can contribute to a motor vehicle crash: the driver, the roadway and the vehicle. The driver is a contributing factor in 93% of crashes, the roadway is a factor 34% of the time, and the vehicle is a factor 12% of the time. This data does not mean that local road owners are free to consider crashes entirely the driver’s fault and not their responsibility. Remember the road is a contributing factor in 34% of crashes. Described below are the many possible contributing circumstances to a motor vehicle crash.

Driver Condition

- **Reflexes:** Slower response time raises crash risk.
- **Attentiveness:** Distracted or fatigued drivers significantly increase the crash risk.
- **Experience:** Less experienced drivers are at an elevated crash risk.
- **Driver aggressiveness:** Aggressive or frustrated drivers take more chances or are more likely to drive beyond their limit of control.
- **Alcohol & drug use**

Human Factors

- **Visibility:** Humans have a cone of vision 20 degrees around the center of their focal point where items of interest will likely be noticed.
- **Expectancy:** Drivers use an understanding of past situations to lessen the mental workload of driving. For example, if a driver on a rural road passes through several intersections without having to stop, they will not expect to stop at the next intersection. Warning signs can alert drivers to unexpected roadway conditions.
- **Consistency:** When designs for roads and traffic control are applied consistently, the recognizable and predictable patterns facilitate drivers' work.
- **Workload:** When drivers become overloaded with driving inputs, they lose the ability to process information. An overloaded driver can be impaired for a short period of time and may also suffer from a temporarily reduced field of vision (tunnel vision). An example of an overload situation is negotiating a complex, busy intersection with too many road signs in rapid succession and the presence of multiple billboards.

Vehicle

- **Handling characteristics:** Newer vehicles have improved handling characteristics, including reduced stopping distance due to anti-lock brakes, traction and skid control, and better cornering behavior. Older vehicles lack these improvements so may be at greater risk of a crash.
- **Maintenance:** Lack of vehicle maintenance, such as poor brakes and insufficient tire tread, can lead to crashes; however, the total percentage of crashes attributed to vehicle malfunction is very low—less than 5% of all crashes.

Roadway

- **Geometry:** Roadway design directly influences safety. Everything from the radius of a curve, or the grade that a road takes through a hill, to the slopes leading into and out of the ditches can alter the safety of a road. Geometric features should be reviewed whenever major road work is planned or when there is a high incidence of crashes at a specific location.
- **Maintenance:** Upkeep of roadside features such as shoulders and signs also affects traffic safety. Some examples of the roadway maintenance necessary to keep roads safe include trimming vegetation overgrowth during summer, clearing drainage structures, anti-icing and plowing during winter, maintaining ditches and shoulders, and replacing worn or damaged signs.
- **Surface condition:** Maintaining the road surface can reduce crash potential. As a pavement ages, it becomes smooth and worn in spots. This can be particularly hazardous in wet weather and for vehicles negotiating curves. Spot treatment of these locations with a high friction surface treatment will address the issue and reduce crashes.

Environmental

Rain, fog, snow and ice can hinder safe travel by reducing visibility and/or traction on the roadway. While controlling the weather is outside of anyone's control, there are ways to make traveling during inclement weather as safe as possible. During periods of reduced visibility, such as at night and during adverse weather events, driver visibility is paramount. Pavement markings, such as lane lines and edge lines, and longitudinal rumble strips help guide motorists and keep them on the roadway. Pavement friction also helps maintain traction between the vehicle and the roadway, which is especially important during wet weather. In addition to an agency's normal snow and ice removal process, paying special attention to intersections, curves, grades, and sections of road with a tree canopy can potentially reduce the number of winter weather crashes.

Assistance with Addressing Crashes and Improving Safety of Your Local Roads

Now that you have an idea of what factors can influence safety on the roadways in your community, you're likely wondering how to address these issues to make your roads safer. As a local agency, you have access to a valuable resource dedicated to assisting your street or highway department personnel in managing the roadway infrastructure. That resource is the Indiana Local Technical Assistance Program (LTAP). The mission of Indiana LTAP is to foster a safe, efficient and environmentally sound transportation system by improving the skills and knowledge of local transportation providers through training, technical assistance and technology transfer. Specific to roadway safety, the HELPERS program at LTAP assists local agencies with traffic operational and safety concerns. HELPERS is the **Hazard ELimination Program for Existing Roads and Streets**, whose primary goal is the reduction of crashes on locally-owned roadways. The HELPERS Engineer is a traffic safety expert who can offer technical assistance, such as

- solutions to reduce crashes on your roadways, including low-cost simple fixes;
- advice to improve roadway safety, including safety for pedestrians, bicycles and buggies;
- engineering studies, often necessary to make changes to traffic control devices;
- assistance in applying for safety funds to implement safety improvement projects;
- Road Safety Audits, necessary to apply for federal safety funding; and
- interpretation of the IMUTCD, the manual that governs the installation of all traffic control devices in Indiana.

The HELPERS Engineer can provide low-cost safety improvement ideas that are implemented using an agency's own personnel. However, sometimes a higher-cost safety improvement project may be recommended. In these cases, the HELPERS Engineer can assist the agency in applying for federal safety funds through the Highway Safety Improvement Program (HSIP). These funds provide 90% of the total project cost for safety improvements. Like most federal funding, the HSIP program is state-administered. To be eligible for these funds, the local agency must meet several requirements including training on the aid process. More information about the state process is available from the INDOT Local Public Agencies (LPA) Program.

Systemic Improvements

Roadway safety improvements have long addressed the "hot spots," where the highest numbers of crashes have occurred. While this approach is still recommended, the addition of systemic safety improvements can help agencies establish a comprehensive safety plan. This is especially important on low volume roadways, where hot spots take longer to develop. Systemic improvements implement a known low-cost safety improvement across many locations in order to increase safety across the entire community. This approach also allows agencies to prevent crashes by targeting high-risk roadway features like curves, hills, and intersections.

Examples of systemic projects include adding curve warning signs to several curves in a county, installing backplates on all signals within a city, and upgrading all guardrail ends from the unsafe buried ends to crashworthy end treatments.

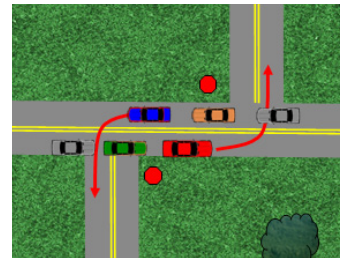
Resources

- ◆ Contact HELPERS at 765-494-7038 or Ltaphelpers@ecn.purdue.edu
- ◆ FHWA on Road Safety Audits. <http://safety.fhwa.dot.gov/rsa>
- ◆ INDOT HSIP (Federal safety funds). <http://www.in.gov/indot/2357.htm>
- ◆ INDOT LPA Program (State program that administers federal funds). <http://www.in.gov/indot/2390.htm>

Geometric Design Features and Safety

Offset Intersections

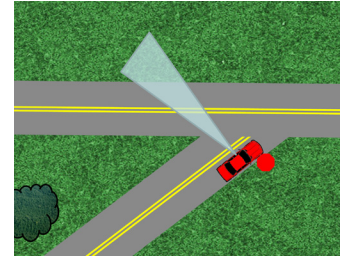
Intersections that have an offset in the opposite legs can be an operational and safety concern. The offset legs can cause vehicles to back up as drivers attempt to make left hand turns. In some cases a “left-hand lock” may occur, where the queues from each lane can block left-hand turns from the opposing lane.



OFFSET INTERSECTIONS

Skew Intersections

Intersections that meet at angles greater than 61 degrees are a safety concern because the driver’s range of sight of oncoming cars is limited.



SKIEW INTERSECTIONS

Approach Grade

Road slope leading into the intersection can influence traffic safety. Steep grades (over 6%) downhill can cause problems with drivers stopping; steep grades uphill can cause problems with drivers starting.

Horizontal Curves

Horizontal curves should be designed for the design speed of the road. A curve too sharp for the design speed can be unsafe, unless posted with an advisory reduced speed limit. Advisory speeds are determined through an engineering study. No statute is required since advisory speeds are not directly enforceable.

Compound Horizontal Curves

Horizontal curves in a road should have one continuous radius. Compound curves are curves with more than one radius—the curve gets tighter as you travel through it. Compound curves cause problems for drivers because they can be fooled into believing they are traversing at a safe speed until the curve turns more sharply, requiring drivers to suddenly brake or risk losing control.

Stopping Sight Distance

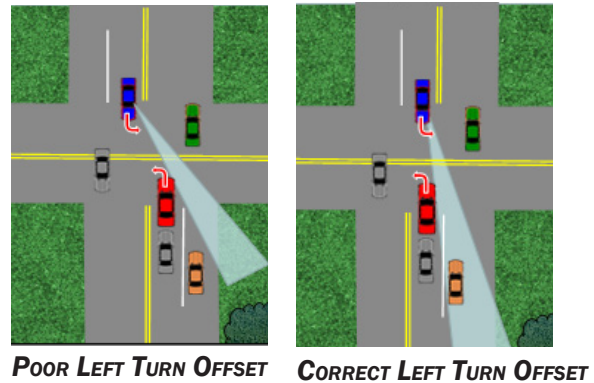
Stopping sight distance is the distance along a road from which a driver can identify a two-foot tall target. The two-foot target corresponds to the height of a typical car’s taillights. When the stopping sight distance is shorter than the distance required to stop a vehicle at the posted speed limit (including reaction time), an unsafe condition can result.

Intersection Sight Distance

The distance a driver can see from a stopped position at an intersection is referred to as the intersection sight distance. A safe intersection sight distance allows the driver to make a determination of whether it is safe to proceed through the intersection. Safe intersection sight distance varies depending on the traffic control and the intended direction of travel by the stopped vehicle.

Left Turn Lane Offset

Ideally, left-turn lanes should be positioned directly across from each other. Simply changing a through lane to a dedicated turn lane without repositioning the lanes can lead to left-turn vehicles blocking each other's view of oncoming vehicles that have the right of way to pass straight through.



Access Control

The number and type of driveways can significantly influence the number of crashes that occur on urban streets. Access control—the act of managing access points to roads—can help ensure that unsafe conditions do not exist. Good driveway placement is a benefit to drivers entering and exiting businesses and to drivers using the roadway.

Crashworthy

An object is deemed crashworthy if it can pass crash testing that demonstrates it will not cause an undue risk to an occupant of a vehicle impacting the object. The National Cooperative Highway Research Program (NCHRP) 350 standards are used to determine crashworthiness. Common objects that are not crashworthy are trees, boulders, stone walls, reinforced sign supports, reinforced mailbox posts, etc. Homeowners who erect non-crashworthy objects on the roadside may be held liable in the event of a crash.

Clear Zone

Roads should be designed with clear zones—areas that should be free from non-crashworthy objects adjacent to the road. The clear zone depends on the speed of traffic and type of road. At a minimum the clear zone is between 7 to 10 feet from the edge of the traveled way for local roads without curbs; however, as speed increases and roadway geometry changes, the clear zone width increases. The clear zone gives drivers that depart the roadway an area to regain control or stop the vehicle without impacting a fixed object or encountering a non-recoverable slope.

Two-way vs. Four-way Stops

Multi-way (all-way, four-way) stop control can be useful as a safety measure at intersections if certain traffic conditions exist, as determined by an engineering study. Multi-way stop control is used where the volume of traffic on the intersecting roads is approximately equal, when sight distance issues exist at the intersection, or when pedestrian conflicts are high. The crash risk increases when drivers are confused whether all approaches are stopping or not; therefore, using the correct signs is important to clearly indicate what traffic control is present at the intersection.

Resources

- ◆ NCHRP 350 Report of Crashworthy Devices.
http://safety.fhwa.dot.gov/roadway_dept/policy_guide/road_hardware/nchrp_350
- ◆ FHWA on clear zones. <http://www.fhwa.dot.gov/programadmin/clearzone.cfm>
- ◆ Simplified Handbook of Traffic Studies: Sight Distance.
<http://www.ctre.iastate.edu/pubs/traffichandbook>

Traffic Control Signs

Good and Bad Aspects of Signs

Signs must be appropriately placed and correctly installed in order to gain a benefit. Signs can improve safety if used correctly and kept in good condition, so they are readable both day and night. Signs can detract from safety if used inappropriately by causing a distraction to drivers or by encouraging drivers to disregard them as irrelevant. Misplaced signs can also represent a financial burden to the agency and can be a hazard to drivers, pedestrians, and workers, so they should be used only when a benefit will be derived. Engineering studies are recommended for sign selection and placement to ensure safety for the community.

Indiana Manual on Uniform Traffic Control Devices

The State of Indiana adopts the federal Manual on Uniform Traffic Control Devices with some changes. The Indiana Manual of Traffic Control Devices (IMUTCD) describes in detail how to properly use traffic control devices such as signs, signals, and pavement markings. The IMUTCD is the basis for official actions that create legally-enforceable traffic control. Compliance with the IMUTCD is mandatory and failure to do so can result in liability and the loss of state and federal road funding.

Placement Rules for Sign Installation

In order for a sign placement to be successful it must meet the following conditions:

- 1) **Fulfills a need:** A sign must meet a warrant in the IMUTCD in order to be installed. Warrants describe the threshold conditions where a benefit can be derived from the installation of the sign.
- 2) **Commands respect:** A sign must be respected by drivers in order for it to be useful. The main barrier to drivers' respect of signs is sign overuse or misuse.
- 3) **Commands attention:** A sign must be within the driver's range of sight in order to be useful. The IMUTCD describes placement for signs to keep them in the driver's range of sight without placing them where they may cause a hazard to road users.
- 4) **Provides adequate time for response:** Drivers must be able to react to a sign in time for it to be useful. Reaction time is divided into four parts:
 - a. *Perception:* Taking note of an object in driver's field of vision.
 - b. *Identification:* Determining that the object is a traffic control sign.
 - c. *Emotion:* Decision to act on the message of the sign. In the case of a stop sign, the decision to stop prior to the sign.
 - d. *Volition:* The physical act of the driver applying the brakes and stopping.
- 5) **Meets drivers expectations:** Signs must be placed where drivers expect them to be placed.
- 6) **Consistent with other applications:** Signs must be applied consistently if drivers are to depend on and trust them. Inconsistent application of signs can lead to unsafe conditions as drivers begin to view signs as irrelevant.
- 7) **Conveys a simple message:** The meaning that drivers should take from a sign should be immediately apparent. If a driver has to consciously think about what a sign means or what to do in response, the sign is not useful.

Controlling Speeds

Speed Limits

Research has shown that drivers typically drive a speed that feels safe to them. Speed limits should be based on the 85th percentile speed –the speed that 85 percent of drivers do not exceed. Research has shown the 85th percentile speed to be near the optimum speed for the roadway. Artificially low speed limits tend to be ignored by the public and can lead to general disregard of all traffic controls and increased crash risk from the speed differential. Traffic safety studies have shown that driving too slow with respect to the average speed can put drivers at the same risk as driving too fast.

Stop Signs are Not for Speed Control

The IMUTCD states that “Stop signs should not be used for speed control.” Over 20 research studies have concluded that stop signs are not effective for speed control and in many cases increase the speeds between the signs.

Traffic Calming

Traffic calming techniques can be utilized to reduce speeds and mitigate some of the negative aspects of motor vehicles on pedestrian and bicycle users. Traffic calming techniques typically revolve around making physical improvements to transportation facilities or rely on education to change driver behavior.

Resources

- ◆ Setting Realistic Speed Limits. Michigan State Police. <http://www.michigan.gov/speedlimits>
- ◆ All-Way Stops Versus Speed Humps: Which is More Effective at Slowing Traffic Speeds? by David E. Clark, P.E. Institute of Highway Engineers. www.ite.org/traffic/documents/AB00H1902.pdf
- ◆ Use of Four-Way Stop Control (research documents). <http://www.ci.troy.mi.us/Government/Departments/TrafficEngineering.aspx>
- ◆ Indiana Manual on Uniform Traffic Control Devices (IMUTCD). <http://www.in.gov/dot/div/contracts/design/mutcd/mutcd.html>
- ◆ FHWA Standard Highway Signs. http://mutcd.fhwa.dot.gov/ser-shs_millennium_eng.htm
- ◆ Traffic Calming Treatments.
 - ◇ <http://www.trafficcalming.org>
 - ◇ <http://www.fhwa.dot.gov/environment/tcalm>

Roundabouts

There are several new types of intersection designs to meet various traffic demands. Roundabouts are a popular choice to address a wide range of safety and congestion problems. Standard four leg intersections have several safety issues that are not present in modern roundabouts.

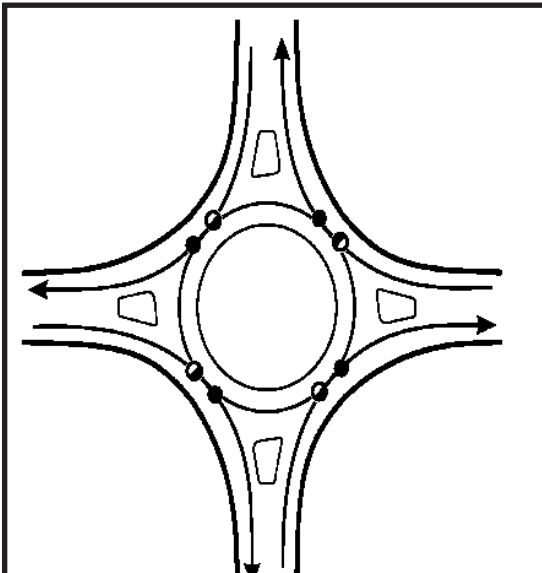
- **Left-Turn Movements:** Left-turn movements are a major factor in congestion at standard four leg intersections because they can delay vehicles going straight if there is no turn lane or passing blister. Additionally, left-turn movements can subject the turning vehicle to crashes from the three other legs.
- **Right Angle Crashes:** Right angle crashes are one of the most severe types of crashes and are likely to produce an injury or fatality. Right angle crashes occur when two vehicles on crossing roadways collide at an intersection. This crash typically happens when one vehicle runs a stop sign or signal.

Modern Roundabouts Safety

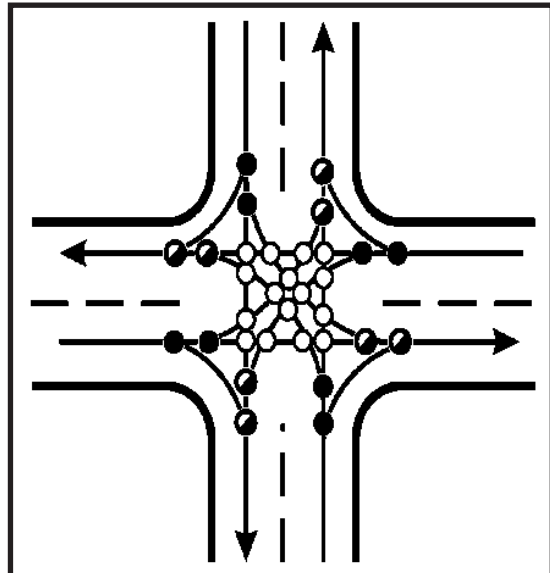
Roundabouts have been shown to reduce the number of crashes (29% to 50% fewer crashes) and the severity of crashes (30 to 73% fewer injury crashes) when compared to a signalized intersection.

Conflict Points

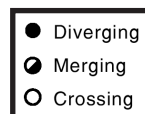
A conflict point is a location in an intersection where traffic from different directions crosses paths and where a crash could result. Designers try to increase safety by reducing the number of conflict points at intersections. A standard four leg intersection has 32 vehicle conflict points, 16 of which are right angle conflicts. Roundabouts only have eight conflict points and all of those are merging or diverging conflicts, which would result in a less severe crash.



CONFLICT POINTS: ROUNDABOUT

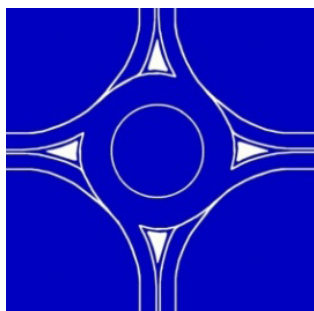


CONFLICT POINTS: 4-LEG INTERSECTION



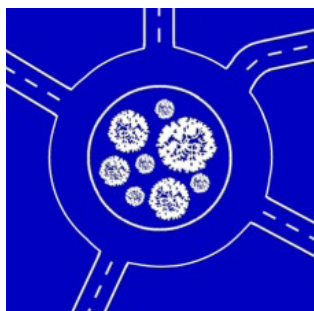
Circular Roadway Confusion

Modern roundabouts are often confused with other types of circular roadways, such as rotaries and traffic circles. This confusion leads to objection if the general public has not used a modern roundabout, but has seen or heard about other types of circular roadways.



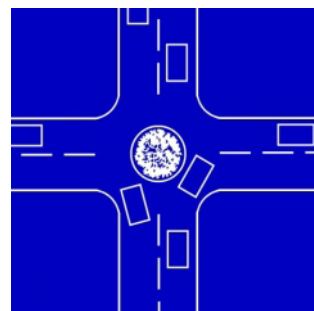
Roundabout

- Size: 100' to 200' diameter
- Speed: 20 mph (single lane)
- Crashes: Infrequent
- Traffic Control: Yield to enter
- Center Island: No pedestrians
- Parking: Not allowed in circle
- Large Vehicles: Accommodated



Rotary

- Size: 400' diameter and up
- Speed: 35 mph +
- Crashes: Frequent
- Traffic Control: Circle yields
- Center Island: Open to pedestrians and trees
- Parking: Allowed in circle



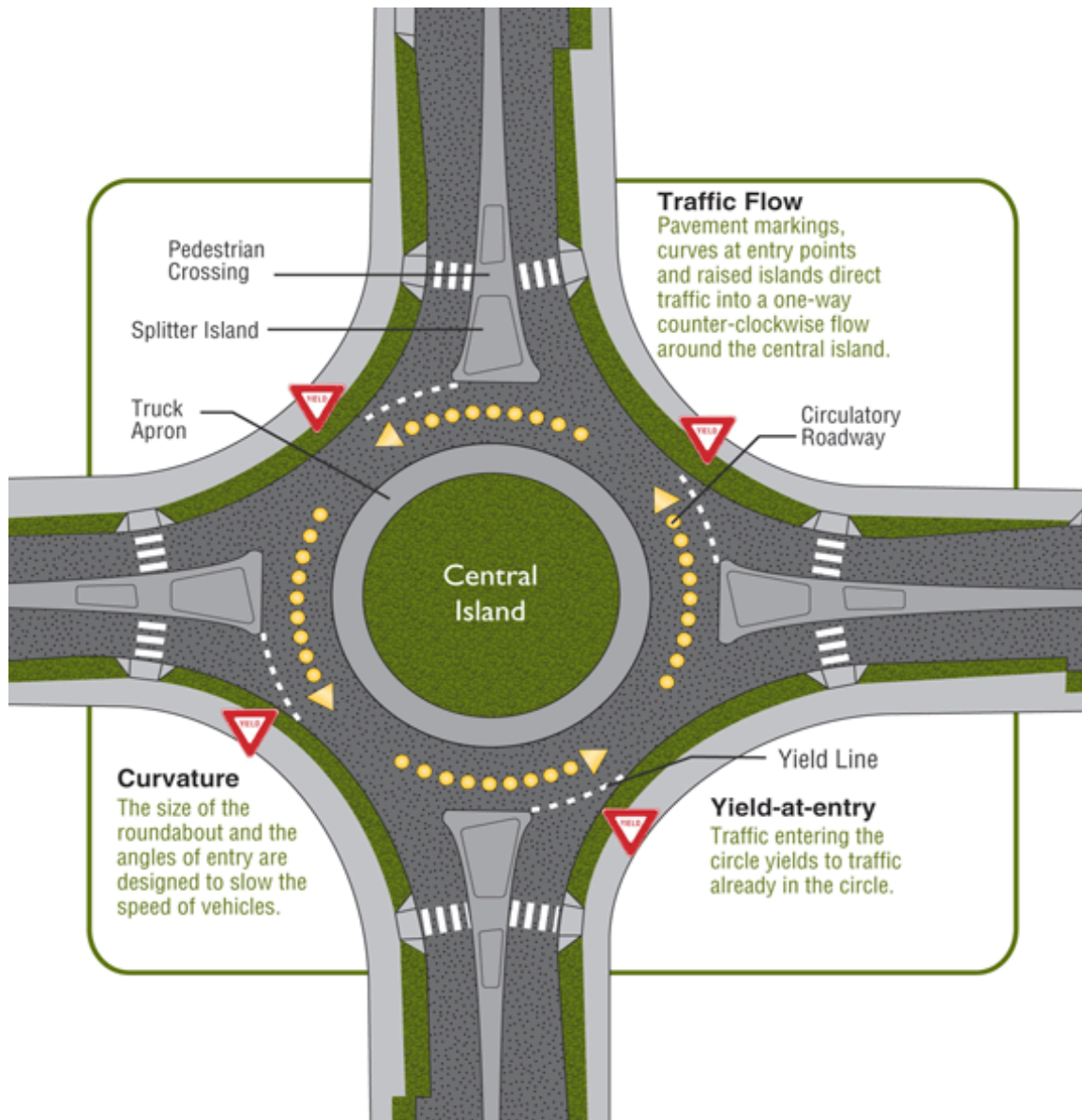
Traffic Circle

- Size: 10' to 50' diameter
- Speed: 10% less than standard intersection
- Application: Traffic calming for low volume/low speed only
- Space Required: Standard
- Large Vehicles: Can be limited

Common Roundabout Misconceptions

1. **Roundabouts restrict traffic.** Not true. Roundabouts can move as much or more traffic than a similarly-sized signalized intersection.
2. **Roundabouts are dangerous and difficult to drive.** Not true. While drivers do take some time to become familiar with roundabout operation, roundabouts are safer than traffic signals.
3. **Roundabouts quickly become congested with just a moderate number of left-turn movements.** Not true. Roundabouts, unlike signalized intersections, treat every turning movement with the same priority. Left-turn movements do not influence roundabout operations.
4. **Large trucks have difficulty traveling through roundabouts.** Not true. Large trucks can easily pass through appropriately designed roundabouts.
5. **Roundabouts cannot be used on high speed roads.** Not true. Traffic signals or stop signs, like roundabouts, require drivers to slow down to negotiate the intersection.
6. **Roundabouts fix every traffic and safety problem.** Not True. There are some traffic, roadway and land use conditions where roundabouts are not a good fit. Fortunately, there are other options available. A thorough traffic study conducted by experts in traffic engineering is always called for when considering alternative intersection designs.

Design Features of a Roundabout



Resources

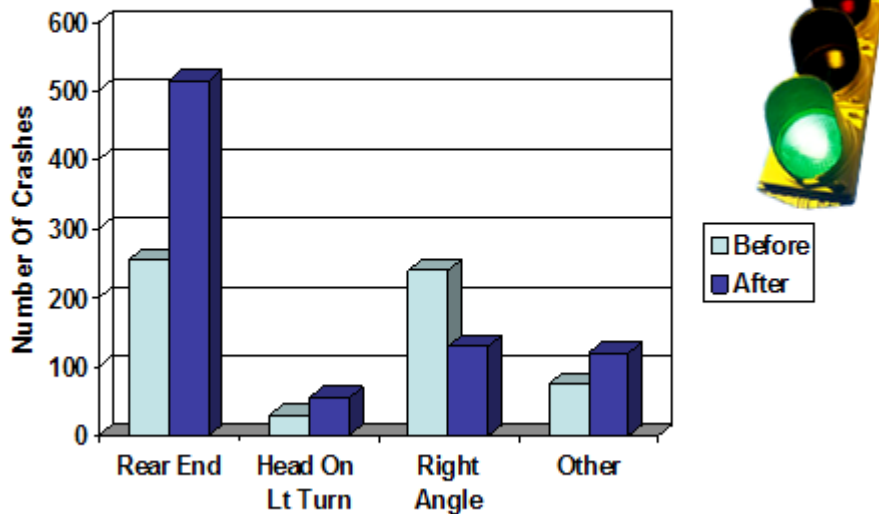
- ◆ Washington DOT on roundabouts. <http://www.wsdot.wa.gov/Projects/roundabouts/>
- ◆ Iowa DOT on rotaries, roundabouts and traffic circles. http://www.iowadot.gov/roundabouts/roundabouts_design.htm
- ◆ Iowa DOT (myths about roundabouts). http://www.iowadot.gov/roundabouts/roundabouts_myths.htm
- ◆ Roundabout Information Guide. FHWA. <http://www.tfhrf.gov/safety/00068.htm>
- ◆ FHWA on alternative intersection designs. http://safety.fhwa.dot.gov/intersection/alter_design/
- ◆ FHWA research on roundabouts. <http://safety.fhwa.dot.gov/intersections/roundabouts.htm>

Traffic Signals

Traffic Signals as a Safety Feature

Traffic signals have very limited application as a safety feature. Traffic signals can actually increase the total number of crashes that occur at an intersection. However, the increased crashes are generally in the form of increased rear end crashes (which are typically not severe), while there is a corresponding reduction in the number of right angle crashes (which are typically the most severe). Traffic signals are dynamic in that they change with time, meaning that drivers need to make a time critical decision whether to proceed or stop.

Before And After Signal Installation
Of 20 Intersections In Michigan



Traffic Signal Warrants

The installation of a new traffic signal needs to meet at least one of the eight warrants in the IMUTCD. Meeting a signal warrant is just one step in the process for determining if a signal installation is justified. An engineering study should be completed for all signal installations. It is important to note that federal aid cannot be used to install unwarranted traffic signals.

- **Warrant 1, Eight-hour Vehicular Volume:** Used in areas where the volume of vehicles is heavy enough over an eight-hour period (usually during normal work hours) to warrant a signal.
- **Warrant 2, Four-hour Vehicular Volume:** Used in areas where the volume of vehicles is heavy enough over a four-hour period to warrant a signal. The volume to satisfy a four-hour warrant is higher than for an eight-hour warrant.
- **Warrant 3, Peak Hour:** Used in areas that experience very short but intense peaks in traffic volume. The volume to satisfy a peak hour warrant is higher than a four- or an eight-hour warrant.

- **Warrant 4, Pedestrian Volume:** Used in areas where pedestrian volumes are high enough to justify a signal.
- **Warrant 5, School Crossing:** Similar to warrant 4, but is satisfied by lower volumes of pedestrians to accommodate children instead of adults.
- **Warrant 6, Coordinated Signal System:** Used to justify a signal to help manage traffic flow in a system of coordinated signals.
- **Warrant 7, Crash Experience:** Used in areas that have a significant history of crashes and where there is a sufficient volume of traffic.
- **Warrant 8, Roadway Network:** Used in areas where several traffic operations issues related to traffic flow in a network of roads, can justify a signal.
- **Warrant 9, Intersection Near an at-Grade Railroad Crossing:** Used to prevent vehicles queued at an intersection approach from stopping on the tracks, when other measures have failed.

Dilemma Zone

A Dilemma Zone is the period of time when the signal changes from green to red and an approaching car does not have enough time to stop or pass through under yellow. Dilemma Zones are a serious safety concern, because they generally result in a vehicle running a red light—drivers most often try to beat the light rather than hit the brakes hard. Dilemma Zones can be eliminated by appropriately setting the yellow timing to correspond with the approach speed of traffic and any vertical grades.

Red Light Running (RLR)

- RLR is the most common crash type in urban areas (about 20% of crashes at signalized intersections).
- Violation frequencies range as high as 1 per 3.5 minutes.
- Nationally, 46% of RLR crashes result in injury.
- Signalized intersection fatalities – 40% are RLR related.
- Economic impact of RLR is \$14 billion annually.

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