Strategies for Improving

Roadside Safety

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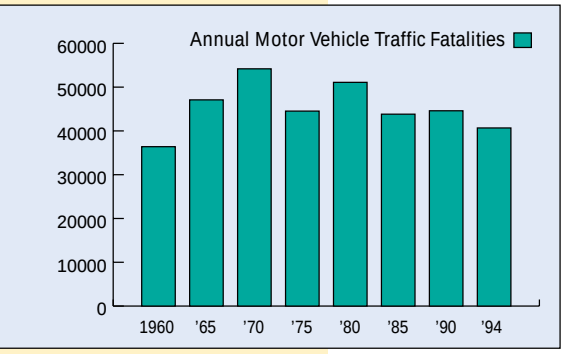
Roadside Crashes: A Serious Highway Safety Problem



On an average day, more than 100 persons are killed and more than 6,000 persons sustain disabling injuries on U.S. highways.

These grim statistics become even more startling when you realize that more people lose their lives on highways *each week* than lose their lives in airline crashes *annually*. The highway fatality rate has decreased dramatically, but too many people die in crashes.

Roadside crashes account for one-third of all U.S. highway fatalities each year.

Each year, more than 14,000 persons are killed and almost 1 million persons are injured when vehicles run off the road and crash. Many of these deaths and injuries result from crashes into trees and poles, which are all too often located dangerously close to the edge of the roadway.

Roadside crashes cost society $80 billion per year.

Traffic crashes impose a tremendous cost to society in medical expenses, worker losses, property damage, and emergency services, as well as pain and suffering. The annual societal cost of roadside crashes is more than three times the amount federal, state, and local governments spend to maintain and operate roads each year.

Rollovers are the most severe type of roadside crashes.

Although rollovers occur in only 15 percent of roadside crashes, they are responsible for more than 25 percent of all roadside fatalities. Nearly 75 percent of all rollovers occur on rural two-lane roads that have limited right-of-way and that were designed to meet older, less demanding standards.

Addressing the Roadside Safety Problem

Highway crashes occur when something goes wrong. It could be a mechanical failure, roadway deficiency, driver error, or a combination of these factors. Addressing the roadside safety problem requires that all elements of the roadway-vehicle-driver system be considered. This system is always in a state of flux as a result of changing traffic, roadway, and environmental conditions. Each element of the system has its limitations and is subject to failure. The elements must work in harmony if the system is to provide mobility at an acceptable level of safety and a reasonable cost.

The Roadway

Roadway geometry, pavement condition, and traffic control devices all play a part in a driver's ability to maintain control of the vehicle and to stay on the roadway. Ideally, highways should be bordered with clear areas that would allow a driver of a vehicle that has gone off the road to either bring the vehicle to a safe stop or safely return to the roadway.

It is often difficult to provide such clear areas, however. In those cases, roadside safety hardware, such as guardrails and crash cushions, should be installed to protect motorists from hazardous objects on the roadside.

The Vehicle

A vehicle's design can affect the likelihood of a crash and the severity of injuries resulting from a crash. As the vehicle fleet changes in response to consumer demand, safety can sometimes be compromised. For example, today's hottest selling vehicles—pick-ups, sport utility vehicles, and vans, which now constitute more than 25 percent of the cars on the road—have features that may make them more susceptible to rollover. To maximize safety, vehicles and roadside hardware, such as guardrails and signposts, should be designed to be compatible.

Emerging technologies are expected to enhance safety by providing the driver with additional information on road conditions and hazards and by allowing collision-avoidance controls on vehicles.

The Driver

A driver's ability to control the vehicle can be affected by the vehicle's design and condition and by roadway conditions. Crashes often occur when the laws of physics overcome a driver's ability to control the vehicle.

Physical and mental limitations can affect a driver's performance. Inexperience, intoxication, fatigue, or emotion can impair a driver's ability to perceive a hazardous situation, make a decision, and take action to avoid a crash. In addition, drivers often talk, eat, smoke, use phones, and adjust the radio as they drive—activities that can distract drivers at inopportune moments.

Very few drivers have been trained in how to maintain or regain control of a vehicle in risky situations, such as when it leaves the roadway. And a driver's overconfidence in his or her abilities or ignorance of safety hazards can lead to risky behavior, such as speeding, aggressive driving, inattention, and failure to "buckle up." Young people are particularly at risk, as highway crashes account for three-quarters of accidental deaths of people between 15 and 24 years old.

Improving roadside safety requires an integrated approach that considers the roadway, the vehicle, and the driver.

A Vision for Improved Roadside Safety

In an effort to address the roadside safety problem, the National Cooperative Highway Research Program undertook Project 17-13, "Strategic Plan for Improving Roadside Safety." Under this project, a distinguished group of experts was assembled and charged with taking a comprehensive look at ways to improve roadside safety. In their deliberations, they formulated the following vision:

A highway system where drivers rarely leave the road; but when they do, the vehicle and roadside work together to protect vehicle occupants and pedestrians from serious harm.

To achieve this vision, the experts outlined five basic missions for transportation agencies:

- **Increase the awareness of roadside safety and support for it.**

Roadside safety cannot be enhanced until the public realizes it is a problem. Significant improvements to roadside safety will require a coordinated effort by transportation agencies, manufacturers, departments of motor vehicles, advocacy groups, law enforcement agencies, and others. Additional funding is needed to implement critical improvements on existing highways, build a higher degree of safety into new roads, and upgrade safety management procedures. Coalitions of government, industry, and civic partners should be formed to promote improved roadside safety. Public information campaigns can be used to make the public, decision makers, and special-interest groups aware of the roadside safety problem and to develop funding support at the federal, state, and local levels.

- **Build and maintain information resources and analysis procedures to monitor roadside safety.**

Improved roadside crash data, traffic monitoring systems, and roadway inventory systems—as well as improved linkages between these data and systems—are needed to monitor the problem and evaluate the effectiveness of treatments. State-of-the-art computer analysis techniques can be used to monitor changing travel and highway conditions and their influence on roadside crashes, to provide better information to decision makers, and to simulate crash events. Safety audits, safety management systems, and other techniques can be used to ensure that resources are used effectively.

Better information will lead to a better understanding of the roadway-vehicle-driver relationship so that cost-effective remedies can be identified. Less expensive methods for ensuring the compatibility between roadside hardware (such as guardrails) and the increasingly diverse vehicle mix are required.

- **Keep vehicles from leaving the roadway.**

Improved highway designs, better control of traffic operations, and adequate maintenance will minimize the occurrence of events that cause a driver to lose control of the vehicle and cause the vehicle to leave the roadway. Innovative vehicle-based systems that help keep cars on the road are being developed. And driver education programs, traffic law enforcement, and legislation can reinforce those driver behaviors that are key to highway safety.

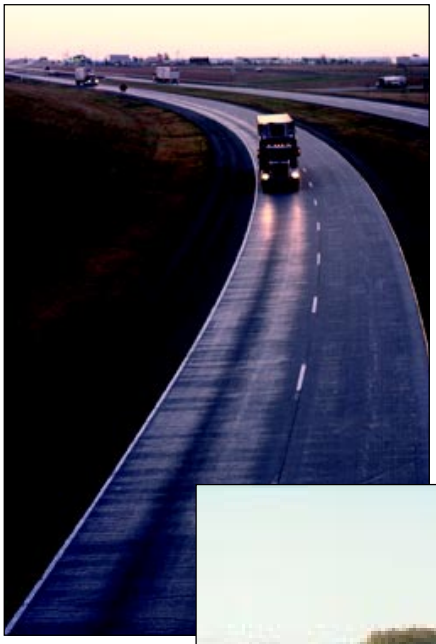
People should not have to pay with their lives when vehicles run off the road.

- **Prevent vehicles that run off the road from rolling over or from crashing into objects on the roadside.**

The likelihood of severe injury or death increases greatly when a vehicle rolls over or hits a fixed object. Utility poles, trees, steep side slopes, drainage ditches, and even safety hardware all pose potential hazards along the roadside. Side slopes and configurations of roadside ditches should be designed to reduce the chances of rollover. Hazardous objects should be removed; if they cannot be removed, some sort of protective barrier must be installed. Vehicles should be designed to be more stable in run-off-the-road situations, and drivers need to be trained in what to do, and what not to do, if their car does leave the road.

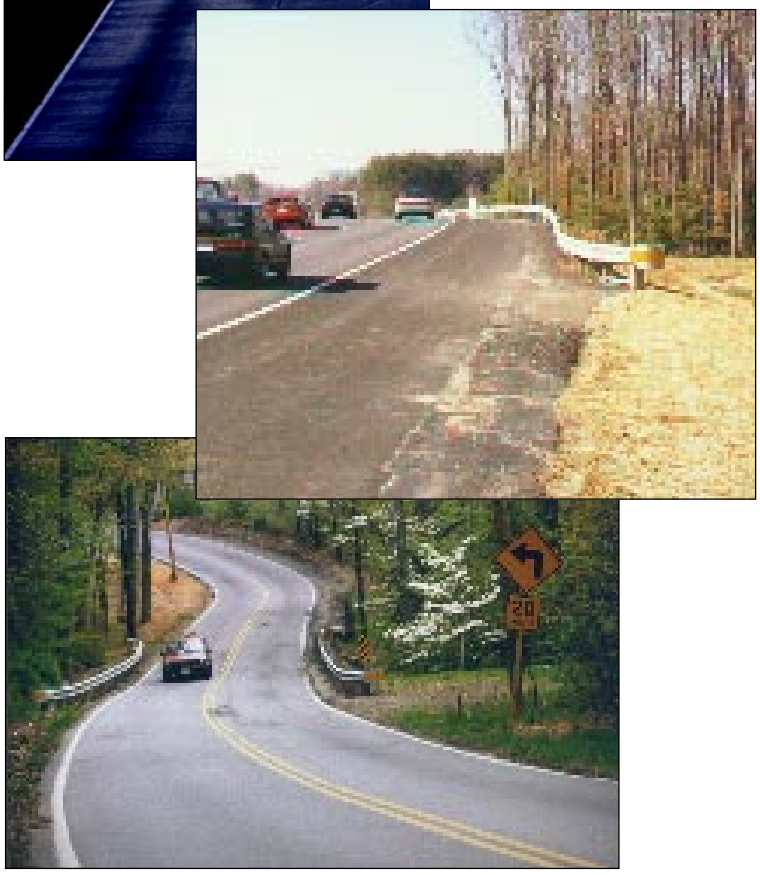
- **Minimize injuries and fatalities when a vehicle rolls over or strikes an object on the roadside.**

When a vehicle rolls over or strikes a fixed object, severe injuries can result if the occupants are not wearing safety belts. Drivers and passengers should be continually reminded to use safety belts, through advertising, training, legislation, and enforcement. Although airbags and padded interiors in vehicles are effective in reducing the risk of injury in crashes, vehicles should be designed to better absorb crash forces. Crash severity can also be reduced by roadside hardware that is designed to absorb impact energy. Better guidance in the selection, design, installation, and maintenance of roadside safety hardware can ensure that safety devices are used where needed most. More-rapid emergency response to highway crashes can also reduce the number of fatalities.



Roadside safety should be an intrinsic part of roadway design, as with gentle curves.

Barriers can be used to shield motorists from hazards alongside the roadway.



Roadside safety is more of a challenge in rural and suburban areas with limited right-of-way.

Translating the Vision into Actions

The NCHRP project identified many potential strategies and actions for addressing roadside safety problems. There are many strategies and actions that can be undertaken immediately to improve roadside safety.

Here are a few examples of these actions.

Install rumble strips on shoulders.

Rumble strips on the highway shoulder warn drowsy or inattentive drivers when their vehicle is drifting off the roadway. They have been effectively used on some Interstate highways, but their potential use extends to other types of roads as well. Rumble strips represent an example of a relatively low-cost highway safety improvement.

Strategically remove or shield trees and utility poles located close to the roadway.

Every day, people die as a result of crashes into utility poles and trees located too close to the roadway. To make travel safer, pole-placement policies need to be reexamined, and programs need to be developed to reduce the number of poles on the roadside. Trees are an even more common roadside hazard. Strategies for removing trees in particularly hazardous locations on the roadside (for example, on the outside of tight curves) and for properly locating new plantings can enhance the safety of the traveling public while maintaining highway aesthetics and environmental quality.

Use public service announcements and citizen initiatives to increase awareness of the roadside safety problem.

Ad campaigns can be effective in informing and reminding drivers of highway safety hazards. For example, MADD (Mothers Against Drunk Driving) has greatly increased awareness of the danger of, and led to impressive reductions in, driving under the influence. Similar initiatives can lead to greater use of safety belts, discourage excessive speed on curves, and warn of the risks in work zones.

Monitor changes affecting safety.

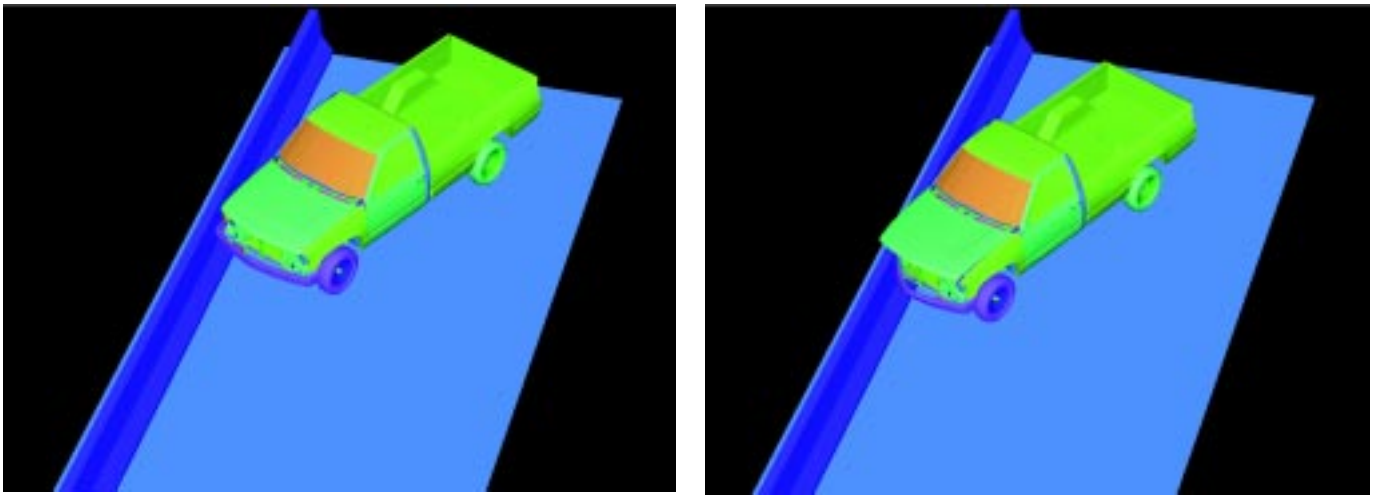
Transportation agencies need to rely on data and analysis tools to manage highway safety. By linking highway features, traffic information, and accident data, agencies can identify hazardous locations, analyze the causes of crashes, make the best use of limited resources, and monitor traffic conditions so that they can be forewarned of changes that might lead to an increase in roadside crashes.

With almost 4 million miles of streets and highways, U.S. transportation agencies face a major challenge in monitoring traffic safety. Most transportation agencies maintain records of accidents and of highway and roadside conditions, but this information needs to be upgraded, expanded, and linked. The public, police, maintenance crews, and others who are often aware of hazardous roadside situations need to be involved in the process.

Implement proactive highway maintenance programs.

Pavements and roadsides must be properly maintained. Timely applications of pavement maintenance treatments ensure that the roadway surface has adequate skid resistance to allow drivers to safely negotiate curves. Proper maintenance means that drivers won't have to swerve to avoid potholes and other problems and that shoulder drop-offs, which can lead to loss of control should a wheel stray off the roadway, are eliminated. Maintenance programs also ensure that adequate sight lines are provided for drivers.

These actions will not provide equivalent improvements in safety, but *through concerted efforts, even modest improvements translate to hundreds of lives saved each year*. The project report outlines other actions that can lead to major reductions in deaths and injuries resulting from roadside crashes.



Emerging computer simulation techniques expedite the analysis of different types of vehicles impacting roadside barriers.

The ever-changing characteristics of vehicles, together with the aging of the driving population, increasing traffic volumes, and deteriorating roads, make improving roadside safety a difficult task. But there are steps state, local, and federal governments can take today to make roadsides and travel safer. These include the following:

- **Provide additional funds to upgrade highway safety programs and roadside hardware.** Over the years, funding for roadside safety has fallen behind needs.
- **Form coalitions of public agencies and private organizations to be "champions" for roadside safety.** Coalitions can heighten public awareness, coordinate safety initiatives, broaden the exchange of information, and promote funding for roadside safety.
- **Improve information resources for monitoring and improving roadside safety.** Improved decision support tools are needed to assist safety professionals in tracking changing conditions, analyzing the causes of crashes, and selecting effective treatments to resolve roadside safety problems.
- **Make the most of remedies known to be effective at improving roadside safety.** They include installing rumble strips, edge lines, and improved guardrails and removing hazardous objects from the roadside.
- **Support research to address the yet unanswered roadside safety questions.** Some of the more important needs are to:
  - Gain a better understanding of the relationship between safety, roadside features (clear zones, side slopes, and roadside hardware), and traffic.
  - Develop refined analysis techniques for modeling the interactions between the vehicle and roadside hardware.
  - Learn more about the dynamics of vehicles that leave the roadway, particularly the interactions between the tire and the soil and the resulting propensity to skid or induce rollover.
  - Understand how drivers react and behave in run-off-the-road situations.
  - Develop in-vehicle systems to warn drivers of danger and improve their response (ITS technologies).
  - Utilize new materials to design better, more cost-effective crash barriers.

Roadside crashes are a huge problem, but there are actions that can be taken today to significantly improve safety.

This digest is an excerpt of a report prepared under NCHRP Project 17–13, "Strategic Plan for Improving Roadside Safety." Gratitude is extended to members of the project panel and the consultants who participated in this effort.

A detailed report outlining the many strategies for improving roadside safety will be published by the Transportation Research Board. Contact the business office (202-334-3214; fax: 202-334-2519) or visit the Transportation Research Board's web site (http://www2.nas.edu/trbbooks/) for more information or to place an order.

This digest is issued in the interest of disseminating information derived from a research project sponsored by the National Cooperative Highway Research Program. Persons wanting to pursue the project subject matter in greater depth may do so through contact with the Cooperative Research Programs Staff, Transportation Research Board, 2101 Constitution Ave., N.W., Washington, D.C. 20418.

Responsible Senior Program Officer:
Kenneth S. Opiela

Subject Areas:

Highway and Facility Design
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National Research Council
2101 Constitution Ave., N.W.
Washington, D.C. 20418