Road Geometry Warning Systems

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Photo: Courtesy of Jaime Sullivan, WTI

Description: Road Geometry Warning Systems are typically focused on addressing heavy vehicle rollovers. However, Road Geometry Warning Systems can benefit all users. The following are Road Geometry Warning Systems:

- Ramp Rollover Warning – notifies heavy vehicles of a ramp that might require a lower speed to ensure that they do not rollover,
- Dynamic Curve Warning – notifications about curvature, typically horizontal, that requires a slower operating speed for safe travel,
- Downhill Speed Warning – helps to reduce the risk of running out-of-control, typically focused at heavy vehicles, when traveling downhill over steep terrain, and
- Overheight/Overwidth Warning – identifies tunnels, bridges or other obstacles that may limit the size of the vehicle that can pass.

Rural Transportation Critical Needs

- ☑ Crash Countermeasures
- ☐ Emergency Services
- ☐ Operations & Maintenance
- ☐ Rural Transit & Mobility
- ☐ Surface Transportation & Weather
- ☐ Tourism & Travel Information
- ☐ Traffic Management

Issues Addressed

- ☑ Road Geometry Warning
- ☐ Highway-Rail Crossing Warning
- ☐ Intersection Collision Warning
- ☐ Pedestrian Safety
- ☐ Bicycle Warning
- ☐ Animal Warning
- ☐ Collision Avoidance
- ☐ Collision Notification
- ☐ Weather Warning

Strategies Achieved

- ☑ Road User
- ☑ Road
- ☑ Vehicle
- ☐ Safety Culture
- ☑ Engineering
- ☐ Emergency Response
- ☐ Enforcement
- ☑ Education

Applicability

- Road geometry warning systems are particularly applicable in rural contexts, as many heavy vehicles carry goods over long distances and many encounter ramps, curvature (both horizontal and vertical), and infrastructure that provide limited vertical or horizontal passage by oversize vehicles. Many such challenges may be encountered when traveling through mountainous topography in rural areas. All of these tools help to address safety because they intend to prevent collisions or rollover crashes from occurring. While some of the examples provide higher technological systems, there are low cost options. For example, radar detection devices can be combined with dynamic message signs to inform drivers of their current speed and how it will not allow them to safely maneuver a curve.

Partnerships

- Applications benefit from collaboration among numerous agencies, which may include:
  - Trucking companies
  - Intercity bus companies
  - Departments of transportation (local, state, federal)
  - Rail agencies

Key Components

- Ramp rollover warning
  - Piezo weigh-in-motion devices
  - Vehicle detectors
  - Fiber optic message signs
  - Computer and associated hardware
  - Controller cabinet
- Dynamic curve warning
  - Inductive loops on corridor
  - Remote traffic microwave sensor on corridor
  - Dynamic message sign
  - Conduit design and installation – corridor
  - Fiber optic cable installation
- Downhill speed warning
  - Inductive loops on corridor
  - Remote traffic microwave sensor on corridor
  - Dynamic message sign
  - Conduit design and installation – corridor
  - Fiber optic cable installation
- Overheight/overwidth warning
  - Infrared light or laser detection systems
  - Warning signs with flashing beacons

Opportunities for Future Expansion

- As connected vehicles move forward, instead of requiring a driver response to the system, a road geometry warning system can communicate directly with the vehicle, adjusting the speed to allow the vehicle to safely navigate the ramp, curve, downslope, or to re-route a vehicle to avoid a tunnel or bridge that is too small for the vehicle size.

Implementation Considerations (General)	Implementation Considerations (Pro)	Implementation Considerations (Con)
•See the Manual on Uniform Traffic Control Devices (MUTCD) for more information on LEDs. •LEDs should flash at a rate of more than 50 but less than 60 times per minute.	•Improves safety on highway ramps or curves with a history of truck rollovers. •Reduces, if not eliminates, rollover crashes. •Impacts of these systems are sustainable.	•Systems still rely on a human response to the warnings. •There is the potential for false positives. •Systems may mitigate rather than completely eliminate crashes.

Examples of Implementation

- **Dynamic Curve Warning System**

A dynamic curve warning system was evaluated on rural roadways in Iowa, Missouri, Texas, Washington, and Wisconsin. For more information about this project, click here and here.

- **Truck Tip-Over Warning System**

A truck tip-over warning system was installed on I-70 in Colorado, just outside of Idaho Springs in the eastbound direction. The intent of the system was to address rollover crashes.

- **Overheight Warning System**

A collision in 2010 between an intercity passenger bus service and a low-height railroad bridge prompted the New York State Department of Transportation to develop an overheight warning system in 2011. However, collisions between vehicles and the bridge are still occurring. There is still an on-going discussion as discussed in the Syracuse Metropolitan Transportation Council's 2050 Long Range Transportation Plan as to whether to restrict access to this roadway by oversized vehicles or to retrofit the bridge. For more information about this project, click here, here, and here.

- **Narrows Oversize Vehicle Identification System**

This project compared oversized vehicle detection systems, assessed their effectiveness, and provided recommendations for an integrated detection and traveler information system to improve safety in the Narrows Corridor of northern California.

Additional Resources

- *Warning Systems Evaluation for Overhead Clearance Detection,* found here: https://rosap.ntl.bts.gov/view/dot/31978
- Alaska Department of Transportation, *Evaluation of Overheight Vehicle Warning Devices,* found here: http://www.dot.state.ak.us/stwddes/research/assets/pdf/fhwa_ak_rd_03_02.pdf
- New York State Department of Transportation, *Bridge Vehicle Impact Assessment,* found here: https://www.dot.ny.gov/divisions/engineering/technical-services/trans-r-and-d-repository/C_07_10_final%20report.pdf

Useful Tip

Existing dynamic message signs can be used in conjunction with detection systems to provide road geometry warnings.

Cost Range

(Cost/financial information, where noted, is based on 2016 dollars (unless otherwise specified). Cost/financial information is estimated, and will vary based on size and scope of project, number of units, etc. In general, capital costs include initial purchase costs of hardware, software, and other required equipment. Maintenance and operations costs include staff time to operate, monitor and maintain systems; data collection; system upgrades; evaluation; etc.)

Capital Costs: The total capital costs for this tool range from low (Less than $50,000) to higher (above $250,000). The complexity of the systems, the year in which it was installed, and whether or not the system has an in-house or contracted configuration all impact the cost. One study surveyed the state of the practice of overheight/overwidth warning systems and reported that the installation cost for an overheight warning system ranges from $15,000 to $20,000 per unit[1]. The Michigan Department of Transportation received estimates of $148,000 to install an active overheight detection and warning system (overheight/overwidth warning) on two sides of a bridge[2]. The Maryland State Highway Administration installed an overheight warning system on southbound MD75 on both sides of a CSX bridge at the cost of $162,000[3]. The New York State Department of Transportation installed an overheight warning system in 2011 at the cost of $322,000 to address collisions between tall vehicles and a low railroad bridge[4]. In Colorado, a Truck Tip-Over Warning System (ramp rollover warning) installed cost $534,934[5].

Operations Costs: The operations and maintenance costs for this tool are low (Less than $50,000). One example reported maintenance costs for an overheight vehicle detection system as $5,000 annually[6].

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