Design Guidelines and Standards

Designing Highways with Older Drivers in Mind
Turner Fairbanks Highway Research Center, Public Roads, May/June 1999

Each year, the average age of Americans increases as the baby boomer generation leaves middle age and enters older adulthood. By 2020, 20% of the US population will be above 65. Chronological age isn’t necessarily a precise indication of driver capabilities, but it is a variable often used in the overall driving equation. Studies have shown that elderly drivers have high rates of accidents, injuries, and fatalities on a per-mile-driven basis. This article presents information on the affect of an increased percentage of elderly drivers on the road and some steps being taken to accommodate them.

Urban Four-Lane Undivided to Three-Lane Roadway Conversion Guidelines
Transportation Research Symposium, Ames, Iowa, August 2003

This paper summarizes the content of the guidelines for the conversion of four-lane undivided roadways to three-lane facilities which were developed in 2001. This guideline identifies several successful examples of conversion and the expected operational impacts along with the factors that should be considered in this type of roadway conversion. This paper deals mainly for the factors and the operational analysis results in the guidelines. In two different operations of similar roadways with either a four-lane undivided or three-lane cross-section, a CORSIM sensitivity analysis approach was used. An investigation of signalized side-street delays was also completed, and the average arterial travel speed impacts of this type of conversion during non-peak-hours compared. According to the results, a four-lane undivided to three-lane conversion can improve roadway safety in some cases.

Towards A North American Geometric Design Standard For Speed Humps

The Purpose of this study was to contribute to the development of speed-hump geometric design standards for North America, where vehicle characteristics, environmental conditions and motorist expectations may be different from those in other countries. Speed Humps are very effective means of calming traffic. The most common design is the Watts profile or circular hump. It is a section of cylinder 3.7 meters long and 75 to 100 millimeters high extending over the width of a street. Most vehicles can traverse the safely at 25 to 30 kmph. These speeds are often considered unrealistically low for many streets in North America that could benefit from traffic calming. Also, Watts profile and similar humps are too abrupt for most heavy vehicles. Other less-severe designs are considered more suitable under these conditions. One such design developed in United States is the Seminole profile or “flat top” hump. The design features the addition of 3m flat sections into Watts profile hump for an overall length of 6.7m2. Research in Europe and elsewhere has led to designs with many different lengths, heights and profiles. This has allowed their use on bus and truck routes, and streets with posted speeds up to 50 kmph. They are designed so that most vehicles will cross them at 5 kmph lower than the
posted speed and are spaced so that over the length of a given street will fluctuate around a predetermined desired speed.

**Geometric Design for Adequate Operational Preview of Road Ahead**

*Author: Gattis, JL; Duncan, J*

This paper discusses minimum geometric conditions that must exist to provide an ample amount of 'preview sight distance' (PVSD) for comfortable and safe operations. The PVSD concept is based on the assumption that the driver views or previews the roadway surface and other cues that lie ahead to obtain the information needed for vehicular control and guidance. The driver needs a minimum PVSD to perceive and respond to upcoming alignment cues; the roadway geometry affects how much PVSD is available for the driver. A roadway designed with geometric features adequate to the design speed would in many cases provide ample PVSD, but a roadway with constrained design features could have inadequate PVSD. The paper includes a derivation of equations to calculate the available preview sight distance on a crest vertical curve and discusses two applications of the PVSD concept to sharp horizontal curves. When a geometric analysis finds that inadequate PVSD exists, upgraded signing or pavement marking to provide drivers with extra positive guidance may be considered as a means of compensating for inadequate PVSD.

**Geometric Design of Low-Speed Urban Streets**

*Tarris, JP; Mason, JM, Jr; Antonucci, ND*

Summary: This paper discusses the Geometric design of low speed urban streets. A research effort is progressing to develop a rational process for designing roadway geometric elements on low-speed urban streets and using a "target" operating speed as the preselected design speed. The goal is to provide geometric street designs that reflect the in situ operating environment. Such an approach produces geometric conditions that result in operating speeds that are consistent with driver expectations and commensurate with the function and purpose of the roadway. The data collection methodology being used to develop a speed-prediction model between operating speed and roadway geometry, roadside features, land use, and traffic engineering considerations is also described. A comparison of design speed and operating speed for one study site is provided as an example of anticipated results.

**Review Of Truck Characteristics As Factors In Roadway Design**

*Harwood, DW; Torbic, DJ; Richard, KR; Glauz, WD; Elefteriadou, L, NCHRP Report*

The report presents guidance for roadway geometric designers on how best to accommodate large trucks on the U.S. highway system. This work mainly involved reviewing the range of dimensions and performance characteristics of trucks currently used on U.S. highways and predicted how these characteristics may change in response to current political, economic, and technological trends. Analysis of those geometric design features affected by vehicle characteristics and an evaluation of the adequacy of current geometric design policy to accommodate the current and anticipated truck fleet were
conducted and presented. Based on their findings, they made recommendations for a number of changes to the American Association of State Highway and Transportation Officials (AASHTO) "Policy on Geometric Design of Highways and Streets" ("Green Book"). The report (1) provides valuable guidance for designers of roads and facilities that need to accommodate large trucks and (2) will assist AASHTO in updating geometric design policy. Also they stated that the information developed in the project will be useful as input to future editions of other documents such as the Transportation Research Board (TRB) "Highway Capacity Manual," the Federal Highway Administration (FHWA) "Manual on Uniform Traffic Control Devices," and the AASHTO "Roadside Design Guide."

**Identifying the Best Locations Along Highways to Provide Safe Crossing Opportunities for Wildlife.**


This report describes and emphasizes the importance of providing for safe crossing areas for large mammals. Specifically, providing underpasses in the correct locations will allow large mammals such as deer, elk, and mountain lions, as safe passage across the road. Providing these safe crossings will result in fewer animal deaths and fewer animal collisions along the roadways.

**PLANNING AND DESIGN OF TRUCK ESCAPE RAMP**

TRB Publications, TRB Accession Number: 755278, Date: 07/10/2002.

The aims of this project are: 1) To document the engineering design and operating experience with truck escape ramps in mountainous terrain, 2) To develop a framework for the engineering of gravity ramps and arrester beds, 3) To modify the grade specific rating system procedure for truck and road conditions in Alberta and British Columbia, 4) Development of planning and operational methods to balance the need between operational efficiency of upgrade and downgrade traffic flow (level of service) and downgrade safety. Upgrade and downgrade passing lanes and truck escape ramps are part of this research.

**Design Speed, Operating Speed, and Posted Speed Practices**

NCHRP Report #504, 7/2003

Within this report the current state of practice of roadway design, with regards to design speed, operating speed, and posted speed, is examined. These design methods are believed to not be as adequate as might be possible. This paper explains the review of current practice and examines how guidelines will be produced, or AASHTO “Green-book” standards revised, to allow for better roadway designs that will provide fewer abrupt alignment changes that can raise difficulties for drivers. Some recommendations from this report are to revise the Green-book to discuss the relationship of the 85th percentile speed with regards to the posted speed limit, to change the text to recognize
freeways as a different functional class because of the different speeds associated with wider lanes, shoulders, and medians, and add information on the state of practice for selecting design speed values.

**A New Solution for an Old Problem.**

This article describes the deployment of concrete anchor-blocks with tie-backs, to prevent an existing landslide from sliding further and blocking or destroying an existing highway. The project was unique in that the final construction had to maintain the existing aesthetics of the area since the project was located within a scenic portion of a national park. The article describes the design process and the very unique aspects of the design and construction procedures necessary for an active landslide. Monitoring was performed for a time after the project was completed, and despite very heavy rains, negligible shifting was observed.

**A New Approach to Highway Design**
Federal Highway Administration, October. 2002.

This article explains how CSD has become an important part of highway design projects in Kentucky. It also describes how Kentucky has developed CSD workshops and training courses in order to make a list of the commitments of each stakeholder as well as to make a clear definition of each commitment. This paper mentions how a CSD approach was considered to redesign Euclid Avenue in Lexington, Kentucky and how public involvement was necessary to have a better efficient project development. In conclusion the purpose of this article is to encourage different professionals and organizations to have training, guidance and information to understand and implement CSD approaches in all states.

**Moving Ahead with Context Sensitive Solutions in South Carolina**
Federal Highway Administration, November 2003.

This article describes the use of Context Sensitive Solutions (CSS) in South Carolina and how CSS are changing the way highway projects are developed and built. South Carolina Department of Transportation (SCDOT) proved through workshops that CSS is really important to analyze and discuss. This article also describes how SCDOT is incorporating CSS into the Cooper River bridge project in Charleston. CSS workshops have been done in the SCDOT since 2002 resulting in new initiatives such as new pilot projects, new policies related to bicycles and pedestrians, and public involvement processes for all significant projects.

**Overhauling Highway Design**
Science, Technology and Environment, 1998

This article explains the necessity of wider highways to be more safe and efficient. These concept and requirements come from the ASSHTO Green Book which is the fundamental
text for engineers. The author of this article states that the idea of safety in highway design should not be related to wider roads and high speeds. Local officials in many regions think that the classical design requirements are questionable, so it is like a “rebellion” against the classical rules. Nowadays; technology could help travel at high speeds without the intervention of wider highways and it could be possible through the use of prototype automated highway systems or automated cars.

**Road Design- A Turn Ahead**


There are always plans to extend or rebuild roads in American communities, both rural and urban communities. It is usual to hear commentaries such as “it is not wide enough or there are too many curves”. However; when projects are presented to straighter, flatter or wider roads there are people who do not want to damage scenery, natural resources, and community character. The conventional approach to road design should be well analyzed in order to satisfy the engineering requirements as well as the environment resources.

**Method for Balancing Cut-Fill and Minimizing the Amount of Earthwork in the Geometric Design of Highways.**

From Journal of Transportation Engineering. 2003

The goal of this paper is to propose a method that balances cut and fill and helps to minimize earthwork so that construction costs can be decreased. This proposed method considers a hypothetical “weighted ground elevation” representing the average of transverse changes in the ground elevation rather than the elevation at the centerline of the roadway. The process of conforming the grade line to the “weighted ground line” would result in a much more economic approach because of the increased balance between cut and fill.

**US Experience with Centerline Rumble Strips on Two-Lane Roads: Pattern Research and North American Usage**

Preceedings of the 2003 Mid-Continent Transportation Research Symposium

This article discussed a survey performed by Kansas State University and Kansas DOT of the usage and methods of centerline rumble strips among various states. While everyone is quick to agree that the centerline rumble strips have been beneficial, there is not yet significant data to back up this claim. While one report indicated that accidents had decreased in a study area, the claim was made by another source that the reduction was not statistically significant. After taking a preliminary look at the various types of rumble strips used by each state, Kansas has chosen two types that it will continue to study before making a decision which type to further implement on highways in Kansas.

**Exclusive Facilities for Trucks in Florida: An Investigation of the Potential for Reserved Truck Lanes and Truckways on the State Highway System**

Preceedings of the 2003 Mid-Continent Transportation Research Symposium
With the increasing importance of freight movement and the additional trucks on roadways, Florida is looking at adding exclusive truck lanes. These lanes would be useful in cases of high truck volume, high truck accidents, or areas that the trucks pose a high inconvenience to other drivers. A number of possible methods exist, including placement of the truck lane and whether or not truck drivers have to pay a toll. There would be high costs involved in such a project, mainly in the acquisition of right-of-way, but in some cases using abandoned rail lines could solve this. The article finished by summarizing some areas within the state that such truck lanes would be useful, both between cities and within cities.

**Ecopassage Reduces Road kills**
July 2003, TR News

This article discussed a project in Florida to reduce road kill by building an ecopass by which the animals could safely get from one side of the road to another. The project included building a 3’5” high wall that followed US 441 for 1.8 miles on each side. In addition, a series of culverts were built under the road for the animals to crawl through. The reduction in animal fatalities (not including tree frogs and birds) was 93.5%! Animals filmed using the ecopass included foxes, otters and even alligators. The article did not discuss the severity of the accidents caused by the road kill, but this has likely made the roads safer for the motorists as well. Additionally, the highway will be more aesthetic to look travel with less dead animals on the shoulder.

**Paved Shoulders On Primary Highways In Iowa: An Analysis Of Shoulder Surfacing Criteria, Costs, And Benefits**
TRANSPORTATION RESEARCH BOARD, 2001

The value of providing paved shoulders adjacent to many higher volume roadways has been accepted in many states across the country. Iowa's paved shoulder policy is considerably more conservative than neighboring states, particularly on rural four-lane and high-volume two-lane highways. The objectives of this research are to examine current design criteria for shoulders employed in Iowa and surrounding states, compare benefits and costs of alternative surface types and widths, and make recommendations based on this analysis for consideration in future design policies for primary highways in Iowa. The report finds that many safety and maintenance benefits would result from enhancing Iowa's paved shoulder and rumble strip design practices for freeways, expressways, and Super 2 highway corridors. The benefits of paved shoulders include reduced numbers of certain crashes, higher capacity potentials, reduced maintenance, enhanced opportunities for other users such as bicyclists, and even possibly increased longevity of pavements. Alternative paved shoulder policies and programming strategies are also offered, with detailed assessments of the benefits, costs, and budget impacts.
An assessment was made as to whether the European 2+1 road design is suitable for use in the United States. A 2+1 road design has a continuous three-lane cross section with alternating passing lanes. This digest describes when a 2+1 design is likely to be effective and presents some recommendations for designing 2+1 roads. Visits were made to Germany, Finland, and Sweden to meet with agency staff, observe 2+1 roads in operation, and obtain data on their traffic operational and safety performance. Because of European experience, the use of 2+1 roads in the United States is recommended. It has been found that 2+1 roads improve the traffic operational level of service for two-lane roads without increasing their capacity. A 2+1 road will generally operate at least two levels of service higher than a conventional two-lane highway serving the same traffic volume. Also, a 2+1 road can operate safely and effectively in areas where minor intersections and driveways provide direct access to the roadway. Major intersections should generally be located in the buffer areas between passing lanes in opposing directions of travel and should have left-turn lanes provided. While 2+1 roads can operate effectively with no separation between the lanes in opposite directions of travel, AASHTO policy states that some separation, however small, between the lanes in opposite directions of travel is desirable. Therefore, a flush separation of 1.2 m (4 ft) between the opposing directions of travel should be considered, where practical. Sweden uses a cable barrier in a flush divider, Finland is considering their use, and Germany considers their use undesirable. It is recommended that use of cable barriers between the opposing lanes of 2+1 roads not be considered in the United States until a full evaluation of tort liability and barrier deflection issues has been completed.

UW guardrail design could improve highway safety for today's larger vehicles
Wisconsin Week, March 17, 1999

With evidence that traditional guardrail designs fail to protect some vehicle classes such as sport utility vehicles and four-wheel-drive trucks, an alternate design is required. A University of Wisconsin-Madison engineer, Lawrence Bank, has designed a new guardrail, named the gray beam, to better restrain the wide range of vehicles on the roadway. It is composed of a glass-fiber reinforced polymer. The redesigned shape also better “captures” the bumpers of a wider range of vehicles. Current designs have been known to cause larger SUV’s and 4x4 vehicles to flip over on impact. This new design will be competitive with steel-designed guardrails.

Highway Light Trespass: Human and Social Factors
ITE Journal, 5/2003 vol. 73, no. 5

A well-designed highway lighting system can provide invaluable benefit to the public through services like: law enforcement, emergency operations, improved traffic flow, and safety of right-of-way users. However, new designs promote the lighting of sidewalks and shoulders and this light spills over into adjoining properties. In some situations, where land is scarce, there is not room for a buffer from the roadway to the
adjacent properties causing a form of light pollution. The purpose of this research project was to determine the acceptance of light spillover into both commercial and residential areas. According to the study done, it was learned that the majority of them accepted it on the grounds of increased security.