COST EFFECTIVE DESIGNS TO IMPROVE HIGHWAY SAFETY

Author:

Brent T Allman, E.I.T.

Construction Engineering

Arizona State University

Responding to the following Topic:

Design of rural and urban roads contributes a lot towards safety of users. Identify some low-cost solutions that could be incorporated into the design of rural and urban roads to reduce the number and severity of accidents that occur on them. These solutions must be practical and easy to use by road agencies.

Introduction:

This paper discusses design safety improvement solutions that are reasonable and cost effective. Research studies for safety effects on design improvements and firsthand personal experience in projects are utilized to identify cost effective design improvements that are practical. Studies reviewed concentrated on the safety improvements related to design safety statistics and their effectiveness. The discussion also includes my firsthand experiences as a certified inspector over the years with these designs during the construction phases. The goal is to better understand the potential effectiveness of these design applications and provide the chance to review various case studies. Roadway design improvements are reviewed in addition to others found in the literature. Design features that are reviewed include: guardrail improvements, adding rumble strip, geometric corrections, and roadway widening.

Roadway Design Improvements Studies:

Studies by the US Department of Transportation (USDOT) provide data and insight on how (or if) these design changes make safety improvements [2, 3, 4, 5]. These studies show the functional safety characteristics of roadway rumble strip, roadway traction improvements and geometry widening. These improvements can reduce the number and severity of crashes that occur on the highways.

Adding rumble strip to roadways, according to FHWA evaluations, are cost effective and have a positive impact on safety for the traveling public [5]. In the study *Safety Evaluation of Centerline Plus Shoulder Rumble Strips* written by the USDOT gives the review that rumble strip is cost effective and improves safety function[5]. The study indicates a total of 20% reduction in crashes due to the addition of rumble strip.

Improving traction on roads is another safety improvement the study *Gaining Traction on Roadway Safety* published by the National Association of Professional Accident Reconstruction Specialists provides a focus on safety improvement design [1]. This study indicated that pavement surface treatments including Hot Mix Asphalt (HMA) overlays, open graded friction courses, chip seal, micro-surfacing, slurry seal, diamond grinding and ultra thin bonded wearing course benefit safety; the analyses considered crash statistics in seventeen States.

Roadway shoulder widening has been shown to benefit safety in three studies, from the USDOT, each varying on road types including Two Way Two Lane (rural) [2], Two Way Four Lane (rural) [3], and Two Way Four Lane (interstate) [4]. These three studies indicate that wider shoulder widths benefit safety and statistical data show a reduction in crashes with wider shoulders compared to a BASE of no shoulder roadway.

Low Cost Solutions:

Some low-cost solutions which can be incorporated into the designs of existing and new highways to improve safety can include items such as guardrail improvements, adding rumble strip, geometric corrections, improving traction and roadway widening.

Guardrail improvements help update current requirement due to vehicles changing in design over time. Adding rumble strip help alert drivers if they are leaving the lane and allow them a warning to correct direction. Geometric corrections allow for safer driving on curves when roadway speeds have been increased. Improving traction helps drivers maintain better control even in wet weather conditions. Roadway widening in the form of adding or increasing the size of shoulder help drivers make recoveries if they leave the travel lane. As well these safety improvements can be funded through FHWA. States have the ability to use federal funding for certain highway safety improvements as well local counties and cities can utilize federal funding to improve the roadways. Particular funding included the Moving Ahead for Progress in the 21st Century Act (MAP-21) and after that the funding continued to the Highway Safety Improvement Program (HSIP) as the core Federal-aid program. The objective of the HSIP program is to attain a reduction in traffic injuries and fatalities on roadways, including local government owned public roads and roadways in tribal lands. The HSIP needs an engineered, planned approach to improving roadway safety on all public roads that emphases on design performance not driver attitude such as drunk driving. Therefore designs meeting the FHWA criteria can be considered for this type of funding. This available funding allows agencies to implement designs at little or no cost depending on the projects and the design [6].

Personal Experience from Project Inspections:

Project inspection information of design improvements is discussed in this section to understand the construction process of the design applications. The experience attained from several safety improvement projects are based on certified inspections. The projects described include the addition of rumble strip, geometric correction, guardrail improvement and a widening project. Adding rumble strip to rural two lane highways is a way to improve safety for the traveling public. During a project on a TWTL county road, new rumble strip installation had no major issues and proved to be a successful project. The existing pavement conditions provided a sufficient base for the installation of the new rumble strip and provided for a clean cut product. However on a rural freeway project the reinstallation of rumble strip did not have a sufficient base for a fully functional rumble strip. The shoulder called for a half inch lift of Asphalt Rubber Asphalt Concrete Friction Course (AR-ACFC) without milling. The existing rumbled strip remained and the reinstalled rumble strip was placed above after the ½" AR-ACFC lift was installed. The purpose of not milling was to save cost on the project. This preservation project resulted in a less functional product if it were milled because the existing asphalt surface was more worn and made for a less clean cut product [6].

One component to geometric corrections on projects is to update super-elevations to higher speed limits as per roadway design guidelines. These improvements can be implemented quite easily depending on the knowledge of the contractor in super-elevations and transitions from a crown to a super-elevation. Various projects have faced improper construction techniques for super-elevation corrections resulting in wrong super-elevation slopes and transitions. However, having an individual who understands the capabilities of equipment and the design of super elevations can lead to an effective product. It would seem to be beneficial to have a construction

guideline for super elevation corrections to inform contractors on super-elevation designs and to provide an understanding to designers of the construction equipment capability for plans. The implementation of these geometric corrections are simple however if the know how is not available implementation can be very difficult for the contractors and will result in future projects having to make geometric corrections again.

Guardrail improvements for roadways are important to provide safety with newer design vehicles and specification. Part of guardrail improvements currently taking place are up-to-date End Treatment installations and new guardrail height designs being implemented. These improved designs have had little general installation issues except in special cases. Installations where super-elevation correction were made afterward in the same project have caused height issues. The guardrail runs did not meet specified height requirements due to the incorrect estimation of the newly geometrically corrected roadway alignment elevation near guardrail runs. These estimated top of roadway elevations were wrong after paving operations took place and left for an out of spec guardrail height because the guardrail was installed at the beginning of the project instead of afterward. Overall except for certain special cases guardrail installation has been a straight forward installation for contractors.

Roadway shoulder widening has had two minor challenges which include proper construction next to the existing roadway and unforeseen existing drainage pipes. Gaining proper compaction and grade next to the existing roadway seemed to cause contractors challenges in construction compared to the other design safety improvements. However, this design application proves to be a very effective design improvement and reasonable to construct and is accomplishable. The second challenge is unforeseen drainage pipes that can cause a hindrance to the construction process. These pipes even if left in place and extended can obscure the structural section of the

widening roadway mostly, the base structure of the road and must usually utilize a concrete cap above the pipe section. This concrete requirement can delay a project production for that section for a day in curing and install time.

Conclusion:

This paper discussed design safety improvement solutions that are considered reasonable and cost effective. The literature review and federal programs evaluated identified several design improvements utilized to identify effective and safe designs. These safety improvements in designs were also re-visited based on firsthand personal experience in the State of Arizona. Findings were that these design improvements can reduce the number and severity of crashes that occur on highways. These safety improvements have been also studied, and are currently utilized to improve roadways using available federal funding; these programs are making these improvements more attractive and even more practical to implement.

References:

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