Commission Background Paper 8A-04
Impact of Lane Additions on Highway Safety

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Introduction

This paper is part of a series of special gap analyses to be prepared for the National Surface Transportation Policy and Revenue Study Commission authorized in Section 1909 of SAFETEA-LU. These analyses are intended to address issues that are relevant to the Commission's charge outlined in Section 1909 that were not fully explored in an initial set of briefing papers that were prepared for the Commission. These papers will serve as background material in developing the analyses to be presented in the final report of the Commission. This particular paper correlates to Module 4J, "Future Infrastructure Design Policies and Standards".

During the Commission meeting in March 2007, a Commissioner asked about the safety impact, if any, of adding lanes to a road (e.g. adding two lanes to a four-lane or six-lane highway). This Gap Analysis paper responds to this question with information provided by experts from the Federal Highway Administration (FHWA) and its Highway Safety Information System.

Background and Findings

There is not a simple answer to the question of how lane additions affect the safety of a highway or street. Lane additions can occur either with or without the addition of new right of way (ROW).

As of yet, we cannot make firm statements about the safety effects of adding lanes to facilities where ROW is increased to accommodate them. This inability is because there have not been sound before-and-after evaluations where one facility actually replaced another one with fewer lanes, leaving other characteristics the same. Studies conducted to date have compared two- and four-lane roads with different curvatures, number of intersections, etc. Due to the different characteristics of the roads being compared, the effects of additional lanes versus the effects of other factors cannot be statistically isolated.

There is more information on the issue of adding lanes within exiting ROW. Typically, lanes are added within existing ROW by making lanes narrower and using shoulders. Again, it is difficult to control for all factors that change when adding lanes. Evidence in one before-and-after study suggests that crash rates can increase by as much as 10 to 11 percent in some cases, but the cause of the increase (e.g., narrower lanes, loss of shoulder, inclusion of two-way left turn lanes, etc.) is unclear. Findings also vary among four-to-five lane conversions and five-to-six lane conversions.

Another study also found mixed impacts on safety based on actual case studies of corridors where lanes were added within existing ROW. The study concluded that, if the use of shoulders can improve traffic flow (which improves some aspects of safety), the negative impacts related to narrow lanes and lack of shoulder can be offset. The study recommended against the use of shoulders and narrow lanes as a means to widen facilities for extended lengths (longer than one mile), especially where truck percentages are greater than 5 to 10 percent.

In conclusion, we cannot generalize the results of existing studies to an assertion that simply adding lanes will contribute to higher (or lower) crash rates. Analysis of lane additions must be conducted on a case-by-case basis, factoring in site-specific conditions, rather than relying on general rules. Computerized tools such as SafetyAnalyst, which will be available to States in the next year or two, will in due course be able to accommodate lane addition analysis for specific facilities.

Studies of the Safety Impacts of Lane Additions

There are some situations where a facility with a lesser number of lanes (e.g., two lanes) is replaced by a facility with more lanes (e.g., four-lanes, either divided or undivided), requiring more ROW. There are other situations, however, where an existing facility (usually urban or suburban) is modified within the same ROW to have added lanes (e.g., existing lanes or shoulders are narrowed, an existing median width is decreased, etc.). Each of these situations is addressed below.

Lane Additions Where ROW Is Added

Past attempts to study the safety effects of adding lanes to facilities where more ROW is also added have compared different classes of roadways (e.g., two-lane rural vs. four-lane rural) to each other. Unfortunately, the comparison is not "clean" in that other characteristics are not usually the same for the two classes (e.g., the curvatures of the compared roads are different, the number of driveways differs, the nature of intersections differ, etc.).

One early study conducted in the FHWA's Highway Safety Information System (HSIS) project compared the non-intersection crash rates of "typical" two-lane, four-lane divided and four-lane undivided roadways in four HSIS States. It showed fairly significant differences in the non-intersection crashes, with four-lane divided rates being lower than those of the undivided classes, but not much difference for non-intersection crashes on the two-lane vs. four-lane undivided sections in the one State that could be studied. Again, it was not possible to control by equalizing the number of intersections or driveways on the different roadway types, which is why intersection crashes were dropped from the study. Clearly, however, there may be differences in intersection crashes when moving from a two-lane to four-lane design. Good before-and-after studies of actual conversions of different types of roads are needed. To date, sound before/after evaluations have not been conducted where one facility actually replaced another one with fewer lanes, leaving traffic and other characteristics the same.

Lane Additions Within Existing ROW

We know somewhat more about adding lanes within the same ROW. In a 1990 study, Harwood (1990) analyzed before-and-after data for 35 projects on urban arterials where existing lanes were narrowed to add additional lanes. He found large crash increases in the conversion of a two-lane road to an undivided four-lane road, but the crash increases were mainly at driveways and intersections, which reflect other factors. When a five-lane road with two-way left turn lane (TWLTL) was converted to a seven-lane road with TWLTL, there was an increase in both mid-block and intersection crash rates. When a six-lane divided road was converted to eight-lane divided road, the crash increase was only at intersections. Hauer noted that it is not possible to separate out the effects of lane width changes from other effects (such as addition of TWLTL or median). Accident modification factors, which represent the safety effects of individual geometric design and traffic elements, could not be developed from this study.

As part of FHWA's HSIS project, Hauer et al., (2004) conducted a more recent study of the effects of converting shoulders and narrowing existing lanes to add HOV lanes on urban freeways. An HSIS Summary describing that report can be found at http://www.hsisinfo.org/pdf/05001.pdf. Here, 50 miles of these lane-addition projects were studied using an empirical-Bayes (EB) before-and-after methodology. The changes involved the addition of a HOV lane to one side of a freeway that had previously had either four or five existing lanes. In all cases, a median barrier was present. The EB analysis results indicated that the four- to five-lane conversions, on the average, resulted in a statistically significant increase in accident frequency of 10 to 11 percent. The five- to six lane conversion projects resulted in an increase in accident frequency of three to seven percent, not statistically significant. The sample size for five- to six-lane conversions was about half that for four- to five-lane conversions, so the five- to six-lane analysis would be less likely to result in statistically significant results as reflected by the larger standard errors.

NCHRP Report 369 "Use of Shoulders and Narrow Lanes to Increase Freeway Capacity," found mixed results among the 5 corridors they studied: crash rates increased at 3, and decreased at 2. The research was not able to identify site-specific characteristics that distinguished locations with positive and negative crash impacts. The report authors' basic observation is that "where smooth flow is maintained, accident rates are lower." And, therefore, they offer the conclusion that "...if the use of shoulders can improve traffic flow, negative impacts related to narrow lanes and lack of shoulder can be offset." The study's recommendations caution against use of shoulders and narrow lanes as a means to widen facilities for extended lengths (longer than one mile), especially where truck percentages are greater than 5 to 10 percent.

"Accident migration" refers to a situation where action to reduce road traffic crashes in one place may result in those accidents resurfacing elsewhere. The examination of possible accident migration to adjacent downstream sites where lanes were added to existing ROW indicated a non-significant increase for the four- to five-lane conversions of 5 to 12 percent, and a statistically significant 17 to 21 percent increase downstream from the five- to six-lane conversions. An effect that potentially offsets the accident migration on the five- to six-lane conversions was a non-significant decrease in crash frequencies for freeway segments upstream of the conversion site.

Improved Modeling

The FHWA is supporting the development of SafetyAnalyst, which will be a set of software tools used by state and local highway agencies for highway safety management. SafetyAnalyst will be used by highway agencies to improve their programming of site-specific highway safety improvements. It will incorporate state-of-the-art safety management approaches into computerized analytical tools for guiding the decision-making process to identify safety improvement needs and develop a system-wide program of site-specific improvement projects.

SafetyAnalyst will include Safety Performance Functions (statistical models estimating crash frequency as a function of average annual daily traffic for different facility types) for four, six, and eight-plus lane urban freeways and four and six-plus lane rural freeways (as well as for urban and rural two-lane and multilane non-freeway facilities, etc.) When completed, these functions will allow a comparison of the safety effects of facilities with different numbers of lanes.

Conclusion

It is not possible to generalize the results of existing studies to an assertion that simply adding lanes will contribute to higher or lower crash rates. Analysis of lane additions, within new or existing ROW, must be conducted on a case-by-case basis. This analysis must address local conditions, rather than relying on general rules. Future versions of SafetyAnalyst will greatly facilitate the ability to do site-specific analysis of the safety impacts of adding lanes to highways.

References

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