PAYOFF OF SAFETY PROGRAMS

H. L. ANDERSON
Associate Administrator for Safety
Federal Highway Administration
Washington, D. C.

FOUR YEARS OF EVALUATING SAFETY PROJECTS

In the past four years there has been a remarkable improvement in safety program evaluation activities. Today we certainly don't have all the answers—but we have far more than we had four short years ago. The reason for our increase in knowledge is a concentrated effort made by the state and the Federal Highway Administration to evaluate the impact of safety improvements funded with federal-aid funds. I would like to report that this effort was initiated because a need was perceived by the states; after all, it's only good management to evaluate their success in reaching their goal. Some states have recognized this for years and have done an excellent job of evaluating their safety activities, but the majority of the states before 1974 had accomplished very little evaluation. Some states still do not routinely evaluate safety projects.

It was the 1973 Highway Safety Act that established a number of specific safety programs and mandated that the impact of those programs on reduction of deaths, injuries, and accidents be evaluated and the results reported to congress annually.

Congress in passing this legislation did us all a favor. For the first time, at the national level, we had to evaluate the results of a national program. In some cases the results were depressing. In others they were exhilarating.

We have evaluated the impact of over $600 million worth of safety improvements made to our nation's highways in the last four years. Last year alone this investment in safety improvements was estimated to have prevented 8,500 accidents. In the final analysis the overwhelming evidence points to the fact that safety improvements to the highway make a substantial contribution to reduction in accidents, injuries, and deaths.
FOUR BASIC HIGHWAY CONSTRUCTION PROGRAMS

About $180 million of these safety improvements were accomplished through the four basic highway safety construction programs for which federal-aid funds are authorized to undertake projects strictly for safety benefits.

These are:

1. Rail-Highway Crossing Program
2. High Hazard Location Program
3. Roadside Obstacle Program
4. Safer Off-System Roads Program

BENEFITS OF THE SAFETY PROGRAMS

Let's take a look at the benefits of these programs shown in Table 1. Overall the effect of these programs was to reduce fatalities 33%, injuries 7%, and accidents 10% at the locations improved. The cost per fatal accident reduced was $157,000. Consider also that $157,000 is an inflated cost. It represents the cost of saving one fatal accident through the improvements, but considers no other benefits in injury or accident reduction. Actually the cost of the overall safety program per accident reduced, either fatal, injury or property damage, is $7,000.

We are reducing accidents through safety programs at a reasonable cost, but the importance of these results is difficult to perceive unless you look at the actual number of accidents reduced through these activities. To date we have evaluated about $180 million worth of projects, but

<table>
<thead>
<tr>
<th>Safety Program Funding Source</th>
<th>Total Cost of Evaluated Improvements ($1000)</th>
<th>Percent Reduction After Improvements</th>
<th>Annual Cost per Accident Reduced ($1000)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Total</td>
<td>Fatal</td>
<td>Injury</td>
</tr>
<tr>
<td>Rail-Highway Crossings</td>
<td>34,102</td>
<td>53</td>
<td>49</td>
</tr>
<tr>
<td>High Hazard Locations</td>
<td>83,143</td>
<td>44</td>
<td>18</td>
</tr>
<tr>
<td>Roadside Obstacles</td>
<td>37,248</td>
<td>32</td>
<td>1(NS)</td>
</tr>
<tr>
<td>Safer Roads Demonstration</td>
<td>24,393</td>
<td>21</td>
<td>-5</td>
</tr>
<tr>
<td>Total- Safety Construction Programs</td>
<td>178,885</td>
<td>33</td>
<td>7</td>
</tr>
</tbody>
</table>

Table 1
just using this relatively small sample, these projects will result in about
1,370 fatalities forestalled, 5,740 fewer injury accidents, and a reduction
of 25,000 accidents during the average 10-year life of these investments.

As a result of the known payoff of this sample of projects, we can
project the benefits we are deriving from the total program. The average
federal funds allocated to the safety construction program are about
$500 million a year. If the entire program produced the same accident
reduction as the original sample, the program would prevent over 8,200
accidents, 2,500 injury accidents, and 580 fatalities each year and would
keep reducing these accidents year after year for the life of the projects.
A continued ten-year program would make a significant impact on our
national safety problem.

Let's take a closer look at the impact of the individual safety con­
struction programs. Notice that the most effective program in reducing
fatalities is the rail-highway grade crossing program. This program
has consistently produced the greatest percentage reduction in fatalities.
It is also the most costly per accident reduced. These results are in­
fluenced by two factors. There are only about 1,000 railroad crossing
fatalities a year, so improvements have to be made at many crossings
to reduce the number of potential fatalities.

Benefits of RR-Crossing Protection

Railroad crossing protection is a very effective accident deterrent
and most railroad accidents have a high severity but this protection is
also very costly. The catastrophic potential of railroad crossing accidents
is undeniable and because of the serious potential we must be willing to
pay a higher price for protection. It's unfortunate we cannot put a
dollar value on potential catastrophic risks.

Benefits of High Hazard Location Program

The program with the greatest overall cost effectiveness is the high
hazard location program. This program has shown a consistent re­duction
in fatal accidents, injury accidents, and property damage accidents
from its inception. This efficiency could be expected since these represent
safety improvements at locations where a relatively high frequency of
accidents have already occurred.

Benefits of Roadside Obstacle Program

The roadside obstacle program is an attempt to make general im­provements to the roadside that will reduce accident severity and acci­
dents. As might be expected, this program has been most major activity
under this program, and while this may reduce accident severity, the
total number of accidents would not be expected to drop. This may account for the only 4% overall reduction in accidents.

Benefits of Safer Roads Demonstration Program

The safer roads demonstration program is a composite of high hazard, roadside obstacle programs for roads off the federal-aid system. These are roads that usually carry lower traffic volumes than the federal-aid system, and have fewer accidents per mile than the federal-aid system, but much higher accident rates. When it comes to reducing the total fatalities on the Nation's highways, the off-system roads cannot be neglected.

PAYOFF HIGHEST ON LOCAL ROAD SAFETY IMPROVEMENTS

The federal mission is to reduce the total number of accidents and injuries occurring on the nation's highways. In order to do this, we must put our efforts where the major portion of the accident problem exists, and that is not on the federal-aid primary system. Allow me to relate some statistics that will help clarify this point. The road mileage of the interstate and federal-aid primary systems, of which the interstate is a part, accounts for less than 20 percent of the nation's total road system.

If we were to make our present interstate system of highways so perfect that we would eliminate all fatalities on these roads, we would reduce the nation's 50,000 annual fatality total to about 46,500. If we were to develop an accident free system of federal-aid primary highways, we could reduce the national death toll to about 30,500. The majority of all fatalities occurring on our nation's highways takes place on roads other than the interstate and federal-aid primary systems.

If we are to make a significant reduction in the national fatality figures, we must concentrate more effort on safety improvement at the local level. Not only does the local road system contribute the lion's share of the traffic fatalities, they are also more hazardous than the federal-aid primary highways. The fatality rate for the local road system is about 30% higher than the rate of the federal-aid primary system and almost three times as high as the interstate fatality rate.

SAFER ROADS PROGRAM ONLY EFFECTIVE IN REDUCING FATALITIES

For some unexplainable reason the safer roads demonstration program has only been effective in reducing fatal accidents. Both injury and property damage accidents increased under this program, but the $95,000
expenditure for each fatal accident reduced was the best return on the
dollar of any program. Accurate accident records are generally lacking
on the non-federal-aid system. This means that many of the improve­
ments undertaken under the safer roads program were developed on the
basis of engineering judgment. As accident records become more accu­
rate, we expect that accident reductions would be more significant.

BEFORE AND AFTER SAFETY RECORDS USEFUL

Where accurate accident records exist, safety improvements to local
roads not only a good target of opportunity for your safety activities,
but have a proven record of being effective. Before-and-after studies
reported by the states indicate that minor safety channelization can
reduce fatalities by as much as 35% and injuries by as much as 50%.
Bridge widening improvements have reduced the number of bridge acci­
dents by over 50%. The upgrading of over 1,500 California railroad
grade crossings to automatic devices resulted in an 80% reduction in
deaths at the upgraded crossings. All of these safety improvements
represent relative low-cost projects, particularly adaptable to county
road systems.

SAFETY PROGRAMS CHANGE CONSTANTLY

It should be pointed out that these safety programs are in a constant
state of change. Congress has recently combined the high hazard and
the roadside obstacle program into a single program. The safer roads
demonstration program has been replaced by the safer off-system roads
(SOS) program for which 50% of all funding must be allocated to
safety projects. In FY 1978 the states obligated 52% of the SOS
program funds for safety. The major expenditure activities included
bridge improvements 23%, paving of one kind or another 43%, traffic
signs 4% and minor structure and guardrail work 5%.

PAYOFF OF SAFETY CONSTRUCTION SIGNIFICANT

It is obvious that the payoff of the safety construction program has
been quite significant. We can be proud of our record as highway engi­
neers in improving the safety of the highways. However, we cannot be
content with our past accomplishments. If we invested our highway
funds wisely, an achievable national goal could be a reduction in the
present fatality rate by as much as 50%. We could never accomplish
this 50% reduction through the categorical safety improvement program
alone, however. The categorical safety program is basically a stop-gap
measure for reducing highway accidents. This program is essential, it is
vital, and it is effective, but it cannot be expected to bring about the systemwide safety improvement needed for a safe environment.

GOOD DESIGN FOR SAFETY

The systemwide improvements are primarily a product of good highway design. It is difficult to measure the effect of good design on highway accident reduction for a number of reasons. First, various specific design features are interrelated and it is difficult to separate the impact of each feature on safety.

Although it is difficult to measure the general impact of design features on safety, there are many specific examples of its importance. The 20% reduction in the accident rate on interstate roads built after 1967 is a glaring example of the impact of good design on safety. Other examples from a recent Pennsylvania Department of Transportation study are shown in Tables 2 and 3.

Widening pavements produced a 53% reduction in fatal and injury accidents. As another example, from the same study, improved super-elevation on curves produced an overall 42% reduction in total accidents, and there are many, many other examples.

Safety Design Changes for Smaller Cars

There is one other facet of highway design that we engineers cannot overlook. The highway must be designed to accommodate the characteristics of the vehicles using it. Vehicle changes are now occurring at such an accelerated rate that many highway features that were considered forgiving ten years ago may now be lethal fixed objects.

Because of the energy crisis, passenger cars are becoming smaller and smaller. In 1967, our rule of thumb was to design to safely accommodate a 4,000 lb. passenger car. Today, most passenger cars are in the 2,000 lb. class and some foreign impacts weigh 1,800 lbs. or less.

Recent crash tests using cars slightly over 2,000 lbs. dramatically showed the impact of lighter weight vehicles on accident severity. A single 3 lb. back-to-back U post sign support is not "forgiving" to a small car. Crash tests into this support with a 2,200 lb. vehicle at 60 mph totally demolished the vehicle and would have caused death or very serious injuries to vehicle occupants. Crash tests with 2½ in. diameter pipe sign supports and small cars produced the same results. These types of supports should no longer be considered forgiving or be used along high speed roadways. Supports that are already in place, such as the back-to-back U-posts along Indiana highways, should either be replaced or modified as quickly as possible in the interest of safety.
Sign posts are not the only design problem created by small cars. Some present barrier designs do not perform well when struck by small cars. Even the New Jersey median barrier design has a tendency to ramp or overturn small cars. At the other end of the spectrum, large trucks have a tendency to penetrate the concrete median barrier if the concrete is not reinforced with steel near the top of the barrier. The FHWA is presently studying modifications to the barrier design in hopes of overcoming these problems. In designing highways we must be constantly aware that vehicle designs are changing rapidly and consider what changes must be made in established policies to safely accommodate the current traffic.
Safe Design: A Responsibility of Highway Engineer

The point is that we must use every engineering tool available to reduce the traffic accident toll on our nation's highways. But the primary thrust to get this reduction, as far as the highway is concerned, must be obtained through good, safe highway design. Every time you design a highway, reconstruct it under traffic, and attend to its maintenance, you are intimately involved in a highway safety program. The heavy burden of this contribution to accident reduction must be the result of the everyday product of the highway engineer including safe design standards, and safe operational and maintenance practices. The categorical safety program will assist us in reducing accidents, but it is basically designed to correct safety deficiencies in the original design that should
not have occurred initially. The opportunity and responsibility for a safe highway environment rests on the shoulders of the highway engineering profession in their day-to-day activities.

Let's not neglect this challenge.