SHOULDER RUMBLE STRIPS:

A METHOD TO ALERT "DRIFTING" DRIVERS

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ABSTRACT

Study of police accident reports in the mid 1980's revealed that Drift-Off-Road (DOR) accidents were the largest contributor to overall accidents on the Pennsylvania Turnpike. In searching for something to alert drivers that they were "drifting," a concept for a continuous shoulder rumble strip pattern emerged. A Federal Highway Administration report described several states' experiments with various shoulder rumble strip configurations. This work and some ideas from individual observations on the Turnpike led researchers to development and testing of a "Sonic Nap Alert Pattern (SNAP)". As the percent of accidents attributable to DOR continued to rise, testing of SNAP proceeded more seriously. A CalTrans report was encouraging in its description of a similar shoulder rumble strip pattern that had proved effective. In 1987, after testing various indented patterns, the first SNAP was installed on the PA Turnpike on a six-mile downgrade that had a history of DOR accidents. After an 18-month evaluation with only one reported accident, a decision was made to install SNAP over the full length of the Turnpike. A more recent summary of data from the first five SNAP installation projects showed a 70 percent reduction in DOR accidents. The SNAP design that was finally adopted was influenced by the Turnpike's vehicle mix and maintenance procedures, but broader applicability is suggested by its success. Reports have been received of other States and highways adopting the exact design and specifications for "SNAP."

SONIC NAP ALERT PATTERN (SNAP)

This paper presents the Pennsylvania Turnpike's development of a new safety feature, the Sonic Nap Alert Pattern, appropriately abbreviated as "SNAP." The Pennsylvania Turnpike's SNAP is a narrow, continuous rumble strip located in the right shoulder, just outside of the edge line of the pavement as shown on our Title Slide (Slide 1). The actual geometrics of the SNAP will be discussed later.

ORIGINAL IDEA

The idea for SNAP originated with the author's review of police accident reports, looking for engineering modifications that could improve safety. Early in 1984 it became apparent that Drift-Off-Road (DOR) accidents constituted a significant safety problem on the PA Turnpike. Some individual observations on the Turnpike and preliminary research led to a 1984 sketch of the original SNAP concept.

Study of existing intermittent rumble strips showed that effectiveness depended on a continuous pattern. Since the Turnpike has a "bare pavement" snowplowing policy, any form of raised pattern was eliminated and only indented patterns were considered. Also, a narrow pattern was necessary because maintenance vehicles travel the shoulders daily for debris collection and the pattern should not encroach on their wheel path. Thus, a narrow SNAP was proposed in the original 1984 sketch. Upon seeing the sketch, the Turnpike's chief engineer thought that it had potential, but would require testing.

During August 1985, tests were conducted on several indentation methods along the shoulder near one of the Turnpike's Maintenance facilities. Using a pavement heater, an indented pattern was "raked-in," similar to the proposed SNAP, which resulted in a loud noise and perceptible vibration in vehicles driving over the pattern.

In the meantime, a Federal Highway Administration report (1) had been secured that indicated other states were experimenting with rumble strip designs to alert drivers that were drifting off the road. The report described a variety of test installations, but was not conclusive on specific designs or future tests.

DRIFT-OFF-ROAD (DOR) PROBLEM

1985 accident data for the Turnpike showed an increase in DOR accidents from 48 percent in 1984 to 51 percent. After analyzing 1986 accidents, it was found that DOR accidents had jumped even higher to 57 percent as shown in the next slide (Slide 2). The Chief Engineer for the Turnpike Commission agreed it was time to proceed more seriously with testing of SNAP.

Further research showed that CalTrans had installed a rumble strip pattern to reduce DORs on a monotonous road between Las Vegas and Los Angeles. A copy of the CalTrans report (2) was secured and its data indicated a 49 percent reduction of DORs. Encouraged by that level of potential effectiveness, a full-fledged design test of SNAP was initiated.

TESTING AT "STAR" FACILITY

Since there were questions about the effectiveness of the proposed 4 inches wide by 1/2-inch deep pattern, it was decided to test various widths and depths as described in the next slide (Slide 3). These included a mix of 2 and 4-inch widths and depths of 1/4 and 1/2 inch. Actual testing was conducted on a 13-mile portion of abandoned Turnpike just east of Breezewood, Pennsylvania. Incidentally, the Commission agreed to redesignate this abandoned roadway as a Safety Testing And Research facility, or "STAR" facility, which is included in the Transportation Research Board Circular (3) on facilities available for highway research. STAR is listed as available for outside use for a variety of research purposes. It is routinely available for Turnpike researchers to try ideas and test products away from traffic.

On June 21 and 22, 1988, the five different SNAP test patterns as shown were pressed into a once-rolled, hot asphalt (ID-2) wearing course at the STAR facility. On July 15, 1988, tests were run using a variety of vehicles, including a Turnpike dump truck and a motorcycle. Vehicles were driven at various speeds over the test patterns with results as shown in Slide 4 for sedans and Slide 5 for the dump truck. The numbers shown for each run and pattern are sound level readings recorded by a decibel meter within the test vehicles. The decibel meter readings favored Pattern 5, which was also the unanimous choice of the various drivers conducting the tests. Effectiveness for trucks was required since they are such an important part of the Turnpike traffic mix.

INITIAL TRIAL ON THE TURNPIKE

With these positive test results, the next step was to locate a site on the Turnpike for full-scale testing of SNAP in live traffic. By this time the author had collected a significant DOR accident database. An assistant, the Bridge Program Manager, entered this data into the computer, producing a printout indicating Turnpike locations of the greatest number of DOR accidents. The printout showed a serious DOR problem existed on the westbound lanes between mileposts 82 and 88. These 6 miles are mostly a 3 percent downhill grade with 16 curves of varying degrees. The computer printout showed 13 DOR accidents on this stretch over a recent 10-month history, yielding an average of 1.3 DOR accidents per month.

After reviewing the SNAP test results and DOR analysis, the Chief Engineer gave the green light for trial use on the Turnpike. A contract was let to install an experimental SNAP on Turnpike "mainline" between mileposts 81.4 and 88.3, and to study its effectiveness. In addition to the SNAP, the contract included repaving with some shoulder slope improvements and installing single-face concrete "Jersey Barrier" where rock cuts were next to the shoulder.The contractor completed work on this experimental SNAP project in June of 1989 and the evaluation period began. The imprinted pattern in the shoulder looked like the one shown in Slide 6. In the meantime, the author and Bridge Program Manager explored the possibility of milling-in the SNAP. The rolled-in method caused a definite limitation on the contractor's phasing of the job, since the SNAP imprinting was tied to the shoulder paving. Some problems had already been experienced in maintaining a full imprint where there were changes in shoulder slope due to curve geometry.

A local equipment distributor was contacted regarding their advertisement about a planer attachment for a skid-steer loader. After a brief demonstration of this planer at the Turnpike's Administration Building, the distributor agreed to demonstrate it at the STAR facility. For this demonstration, the distributor milled-in a SNAP test strip adjacent to and in line with the prior SNAP test strips. This milling-in procedure went remarkably well, although the basic pattern had to be modified to a width of 7 inches to achieve a full 1/2-inch depth at the center of the cut using a planer drum of about 24 inch diameter. On January 19, 1990, test runs were made over this milled-in SNAP Pattern, which looked like the one shown on Slide 7. These subsequent tests yielded decibel readings averaging 3 decibels higher than Pattern 5, which had been adopted as our standard. Therefore, specifications could call for either a rolled-in or milled-in SNAP, and the Turnpike Standard Drawing and Specifications were revised accordingly.

In January 1990, a summarization was made of the accident history for the 18 months since the original SNAP was installed. The study showed that there was only one reported accident, but it could not be verified that this accident was a DOR. During this 18-month period, observations revealed no problems with debris, water, ice or snow retention in the SNAPs. Armed with this most favorable safety record, the Turnpike Commission committed to installing SNAP system-wide.

FIRST FIVE PROJECTS - REFINING METHODS AND COSTS

By May 1992, the Pennsylvania Turnpike had completed five repaving projects that included SNAP. Follow-up inspections of our first SNAP installations revealed no noticeable degradation of the SNAP imprints.

During early contracts, a definite contractor preference for the milled-in SNAP became apparent. Milling-in SNAP after repaving and line painting proved to be much more practical than the roll-in method.

One of the first subcontractors fabricated a machine that has four tandem milling heads to cut four SNAPs at a time, moving ahead and cutting another four SNAPs and so on. Another early contractor used the services of a subcontractor who had modified a diamond surface planer to cut the SNAPs. A forward drive cam automatically drops and raises the cutting drum to cut-in the SNAP in a continuous forward motion. This machine uses water to cool the ganged diamond cutting blades. An onboard vacuum system collects the cutting debris. This machine discharges the slurry beyond the shoulder or pumps it to a storage truck in the construction train for disposal.

For cost estimating purposes, several contractors advised that the price of the SNAP imprint should settle to about a dollar per imprint. The 1991 contracts were let with the unit cost of the SNAP averaging one dollar. A 1992 PennDOT resurfacing contract for 5.5 miles of U.S. Route 22, east of Lewistown, Pennsylvania, drew bids averaging seventy-five cents per SNAP. This PennDOT contract used the Pennsylvania Turnpike's Special Provisions. Late 1992 Turnpike bids indicate the unit price for the SNAP imprint should stabilize under fifty cents per SNAP. An early 1993 SNAP project was let with a low bid of thirty-eight cents per SNAP. This is close to $2,000.00 per mile of SNAP.

FAVORABLE RESULTS - ACCELERATING THE PROGRAM

In May of 1993 a follow-up study was made of the first five completed SNAP projects to confirm the effectiveness of SNAP. Data was extracted for all accidents where the first object hit was the guide rail or embankment within the milepost limits of early SNAP installations. To eliminate the effect of the different

number of months studied, the data was reduced to "Accidents per Month" (A/M). Results are shown in Slide 8. As indicated in the footnote on the slide, at least a continuous year of data is included on each roadway segment, both before and after installation of SNAP, so seasonal effects should be minimal.

These latest results verify the great potential for DOR accident reduction through the installation of SNAP. However, if SNAP had been cycled in with normal repaving projects, it would take nearly 10 years to complete installation of SNAP on the entire Turnpike. Therefore, an accelerated program was established to include SNAP in contracts for roadway resurfacing in 1993 and 1994, and to go back with contracts specifically to install SNAP on recently paved sections. By the end of 1994, this program proposed to have over 80 percent of the Turnpike system protected with SNAP. The remaining roadway will have the SNAP added as these sections are due for their scheduled repaving during 1995 through 1998.

A SAFER TURNPIKE

In conclusion, the Pennsylvania Turnpike has experienced a 70 percent reduction in DOR accidents by the use of SNAP on five diverse projects over substantial time periods. This 70 percent DOR accident reduction implies a great opportunity for similar reduction on all tollways, the Interstate highway system and other rural highways. Pennsylvania Turnpike officials, state police and even contractors are quite enthused about the prospects for a safer Turnpike. The Turnpike has received numerous favorable comments from both truckers and motorists regarding SNAP. In fact, Turnpike officials see SNAP as the next major safety innovation leading to much safer and forgiving highways. Several reports have been received about other States installing SNAP using the exact design and specifications described in this paper.

ACKNOWLEDGEMENTS

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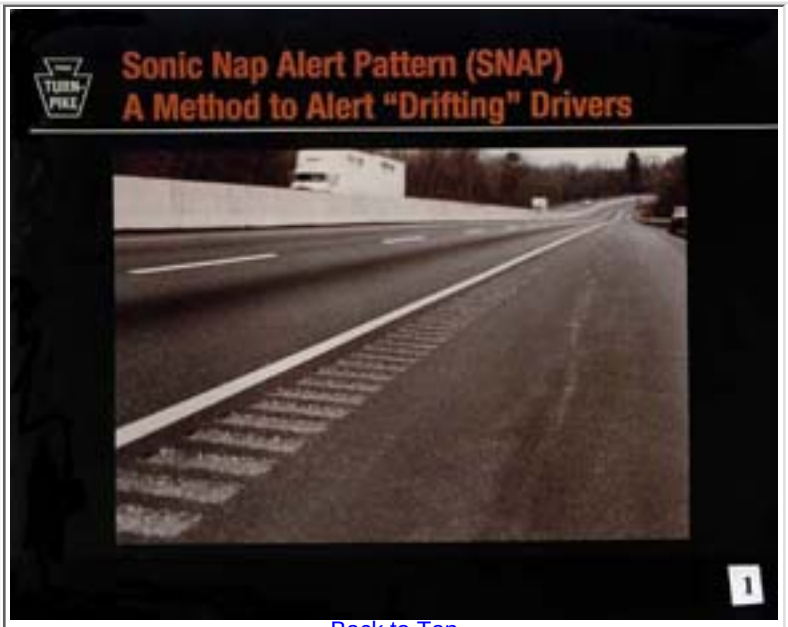
REFERENCES

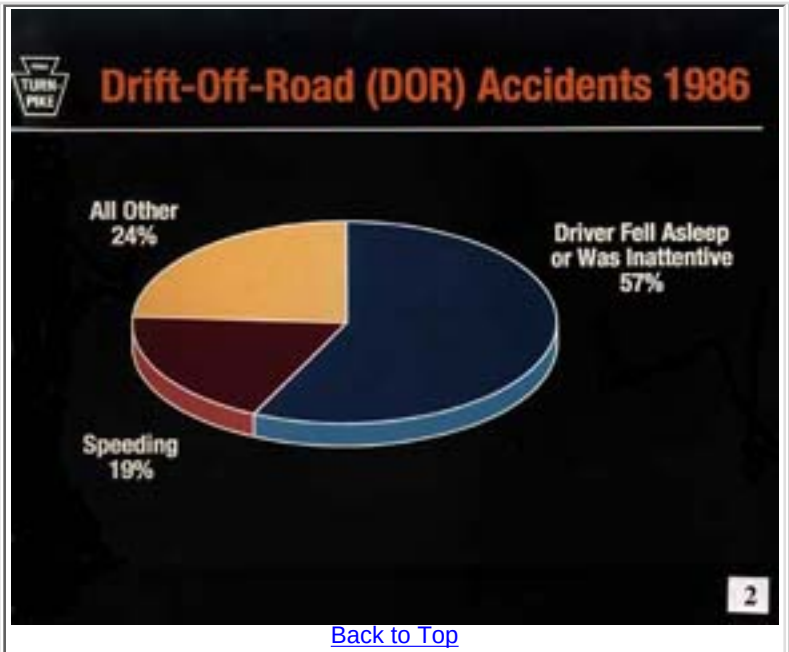
1. C.M. Ligon, E.C. Carter, D.B. Joost, W.W. Wolman. *Effects of Shoulder Textured Treatments on Safety.* Report FHWA/RD-85/027. FHWA, U.S. Department of Transportation, August 1985.

2. J.H. Chaudoin and G. Nelson. *Interstate Routes 15 and 40 Shoulder Rumble Strips.* Report Caltrans-08-85-1. California Department of Transportation, August 1985.

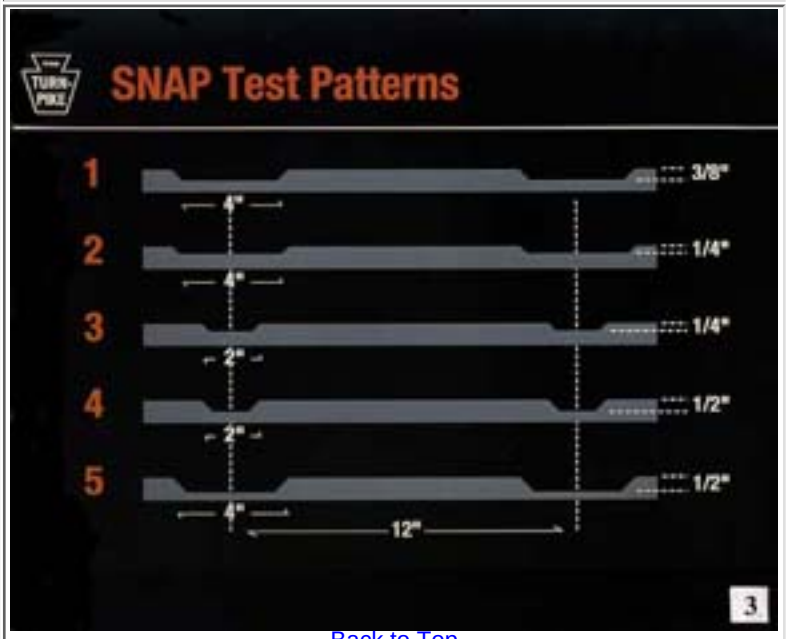
3. *Inventory of Special Facilities for Highway Research.* Transportation Research Circular Number 394. TRB, National Research Council, Washington, D.C., April 1992.



Back to Top

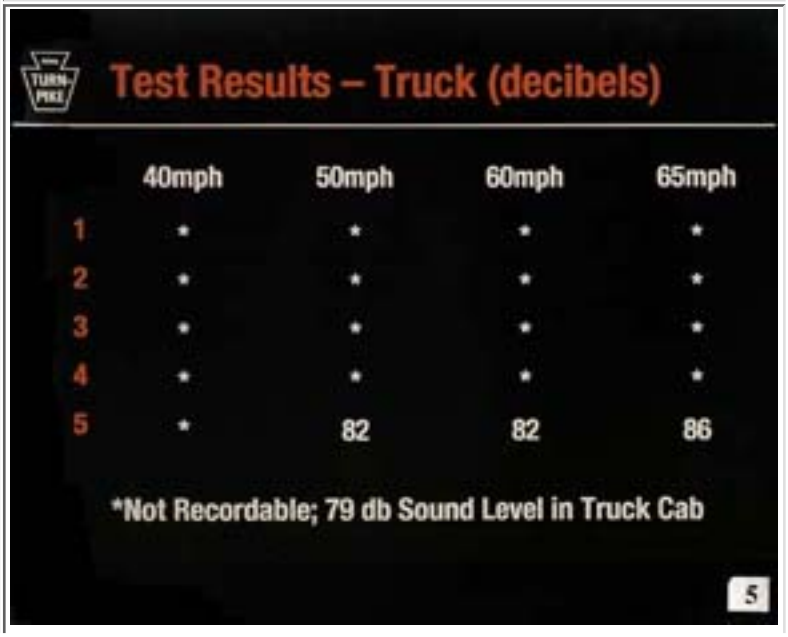


Back to Top



Back to Top

Back to Top



Back to Top

Back to Top

Back to Top

Back to Top