# RESEARCH AS A PROBLEM-SOLVING SERVICE

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•MOST highway department research budgets consist primarily of highway planning and research (HP&R) funds. The allocation of federal funds for HP&R activities is based on a percentage of the total federal funds, mainly for construction, allocated to the state. Our feeling in the State of Washington is that these funds should be spent in the best way to improve the state's highway transportation services for our citizens.

Our research program developed from materials testing activities in such areas as portland cement concrete and asphalt pavements, subgrade materials and construction techniques, paints and delineation devices, and behavior of concrete and steel structures—that is, essentially in the basic and applied research fields. Today we have programs under way in such non-material areas as avalanche control; disposal of waste water from rest areas; social factors affecting highway transportation operations; development of toll-booth ventilation systems; noise levels adjacent to highways; environmental factors pertaining to highway operations; reduction in reflected waves from floating structures; and rainwater runoff from highway structures. However, we have not forgotten that we still have materials problems—development of a pavement management system, reduction in pavement surface wear from studded tires, development of skid-resistant pavement surfaces, and the like. Our philosophy regarding the national research programs (NCHRP and FCP—the Federally Coordinated Program of Research and Development in Highway Transportation) is that programs having regional or national implications should be carried out under the NCHRP or FCP and the states should pursue research in problem areas related to their own particular highway operations.

Each of the projects I have mentioned was stimulated or triggered by a problem arising in one of our highway functional areas: planning, design, construction, maintenance, and management. I will describe several of these problem areas and our efforts to provide solutions.

Let me start with avalanche control. "Control" may be a bad choice of words. Maybe I should call it development of a system to forecast avalanche conditions and to do something about it when an avalanche occurs.

The North Cascades Highway crosses some of the most scenic mountain country in the world, from Puget Sound on the west through the Cascade Mountains to a point about 75 miles north of Wenatchee on the east. The highway was opened in September 1972 and closed in November 1972—not permanently, but at least until May or June of 1973. The reason is that approximately 90 avalanche paths cross this highway in some 50 miles. In addition, we have two other major mountain pass highways that are kept open all winter, plus several others that are closed because it is too dangerous and uneconomical to keep them open. (We have more than 1,000 inches of snow per year in some Cascade Mountain areas.)

We needed some means of determining the conditions under which the avalanches would form, when it is best to trigger the avalanche, and what the best methods are for triggering or holding back a possible avalanche or controlling it when it does come.

Figure 1 shows a typical avalanche area along the North Cascades Highway. The starting zone and paths of previous avalanches are clearly indicated.

Speaking of winter, 4 years ago studded tires were legalized to assist drivers in crossing our mountain passes, getting to and from our excellent ski areas, and in and out of frozen driveways and side streets in a convenient and safe manner. Two years ago we noticed strange things happening to our road surfaces. Our delineation markers were losing their reflectivity, previously grooved areas were becoming smooth, coarse aggregate was being exposed and polished. Last spring transverse reinforcing began showing through the deck of the Evergreen Point Floating Bridge across Lake Washington in Seattle (Fig. 2).

To obtain better data on rates of wear, we established a research program using the test track at Washington State University to quantify whatever was happening on our highways. Figure 3 shows ruts resulting from studded tire wear on the test track. We are now testing studded-tire-equipped vehicles in cooperation with the Washington State Patrol to determine stopping distance and maneuvering characteristics on wet and dry pavements.

Reflected waves from the floating bridges across Lake Washington changed prevailing wave patterns in the lake. Various means of reducing reflected waves were studied and tested by the University of Washington using scale models. The university then built a test section of a wave attenuator to test the laboratory results against a full-size prototype to determine if scaling is realistic. Figure 4 shows the prototype installation on the Evergreen Point Bridge.

In Washington State we have some of the most beautiful safety rest areas in the country (Fig. 5). However, the conventional septic tank and drain field systems installed have not been suitable to meet the loading requirements. Several failed after a few weeks of operation. We tried to build larger conventional systems, but restrictions in area available and effluent disposal still cause problems. We use lagoons in eastern Washington, where rainfall is relatively low, and in some areas effluent is used for watering grass. We are presently experimenting with recycling and incinerator disposal systems in some rest areas.

We have recently been faced with the establishment of truck noise levels. What levels should we set? Should we use California standards? The truckers said, "We can't meet your proposed standards and still operate." We requested the Applied Physics Laboratory of the University of Washington to measure noise emissions and found to our surprise that some of the largest tractor-trailer rigs operating at maximum allowable freeway speeds were presently operating below the proposed levels. We obtained hard factual data to back up our legislative proposal.

Carbon monoxide concentrations during rush hours were a problem for toll-booth operators on the Evergreen Point Bridge across Lake Washington. The University of Washington's Air Resources Group studied the problem, installed CO monitoring equipment, and measured the gas concentrations in and adjacent to the toll plaza. Based on tests of a laboratory prototype, we installed a test ventilation system in one booth. Concentrations previously as high as 300 ppm were reduced to less than 5 ppm by the new system. We are now installing a complete system to handle all booths in the toll plaza.

In the development of our pavement management system, two devices were developed at Washington State University under a research project entitled "Pavement Deflection—Dynamic." One device, the size of a suitcase, is to be used to examine specific small sections of roadway; the second is intended to be towed down the highway at a speed of 30 mph. These devices work on the principle of shock waves traveling through the pavement. Figure 6 shows the suitcase model at the Washington State University test track.

The Seattle Highway District had 300 requests for possible joint use of areas within, adjacent to, or above or below highway rights-of-way in the greater Seattle area. Evaluation and selection criteria were needed to determine what joint use was possible and practicable. A Stanford Research Institute study developed guidelines that include the following major topics: (a) precedent for joint development, (b) description of joint development, (c) fundamental considerations and basic policy, (d) general criteria analysis, (e) air quality and noise, (f) identification of community and neighborhood goals, (g) comparative display procedure, (h) implementation, and (i) new concepts for joint development. Starting with the chapter on joint development description, work sheets are included in each chapter for use of the evaluator.

In summary, our philosophy for research is short- and long-range problem-solving for Washington State. The kinds of results I have described indicate our efforts to solve these problems. And this our management understands.

Figure 1.

Figure 2.

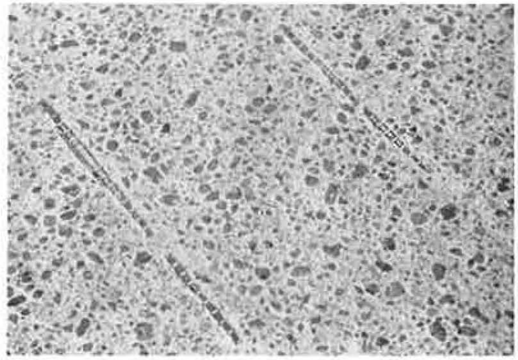

Figure 3.

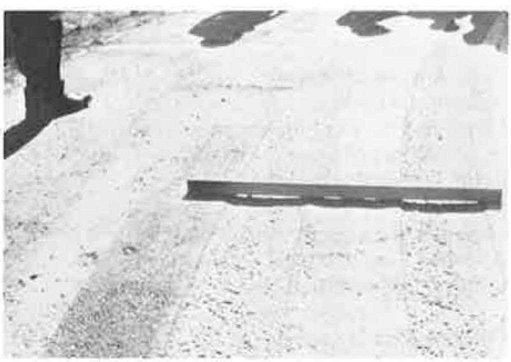

Figure 4.

Figure 5.

Figure 6.