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Washington State's Experience

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# **National Experimental and Evaluation Program**

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NATIONAL EXPERIMENTAL AND EVALUATION PROGRAM

WASHINGTON STATE'S EXPERIENCE

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Prepared for

WASHINGTON STATE TRANSPORTATION COMMISSION

DEPARTMENT OF TRANSPORTATION

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## FORWARD

The National Experimental and Evaluation Program (NEEP) was initiated in 1986 to fill a need to focus national energies and talents on solving the more significant highway problems of the day. During the 14-year period following its inception, 28 projects were included in the NEEP.

The NEEP encouraged experimental features, on Federally funded highway construction projects, that were considered of national significance. The program was officially terminated in 1983 and replaced with a new Special Experimental Features category designed to assist state highway agencies fund the evaluations of selected features of national interest.

This document summarizes WSDOT's experience with the NEEP projects.

## NEEP PROJECTS

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NATIONAL EXPERIMENTAL AND EVALUATION PROGRAM

WASHINGTON DEPARTMENT OF TRANSPORTATION EXPERIENCE

NEEP NO. 1 - GROOVED TRAFFIC STRIPES

OBJECTIVE: Evaluation of lane line striping placed in shallow grooves in both asphalt and Portland Cement Concrete pavements. Normal traffic paint was used and stripe visibility was tested.

EXPERIENCE: The Department has used a variety of durable materials in shallow grooves at various locations throughout the state. Materials that have been used to fill the grooves are Cleanosol, White Cement Grout, and Concessive 1064 (White), Thermoplastic, Methyl Methocrylate, and Epoxy. The grooved stripes have worked satisfactorily under all climatic conditions, except wet night conditions. The visibility on wet nights is diminished due to the water that lays over the pavement and grooved areas. The grooved traffic stripes work quite well and provides good visibility on curves with a grade and hills.

The Cleanosol, White Cement Grout, and Concessive 1064 (White) materials seem to be the most durable and are capable of withstanding the effects of sanding operations, studded tire wear, chain wear, and snow plowing. The use of grooved stripes have proven to be an asset for the driving public. The Department uses grooved striping for center lines and for lane lines on multiple-lane highways, mainly on one interstate mountain pass highway. A project has just been completed which will evaluate three striping materials; (1) Concessive 1170, (2) Lafrent System 400, and (3) Norline.

## NEEP NO. 2 - MOTORIST-AID SYSTEMS

OBJECTIVE: Evaluation of motorist-aid call box systems.

EXPERIENCE: The Department has installed call boxes that are a direct line to Washington State Patrol Office on several bridges throughout the state. The boxes are subject to a high rate of vandalism. To date, the Department does not have any records that indicate the usage or benefits gained from the call boxes.

## NEEP NO. 3 - TRAFFIC MARKING BEADS

OBJECTIVE: Determination of the performance and economy of beads having more uniform gradation and lower application rates. Project prompted by the marketing of so-called flotation-type beads.

EXPERIENCE: The Department has tried limited applications of flotation and uniform bead gradations. Variations in size is necessary to ensure adhesion with pavement surface texture variations. It has been determined that large beads and flotation beads do not penetrate the fast drying traffic line paint adequately.

The most successful beads are the varying graded beads in that their adherance to the paint is much better. The application rate of the large beads and flotation beads, with respect to varying graded beads, appears to be the same. It has been determined that the silean treated beads adhere to the paint better than plain glass beads or other types.

## NEEP NO. 4 - IMPACT ATTENUATOR DEVICES

OBJECTIVE: Evaluation of the effectiveness, economy, and maintainability of impact attenuation devices (originally called "crash cushions").

EXPERIENCE: A variety of impact attenuating devices have been installed by the Department with varying success. These devices include sand barrels, hydro cushion, hi dry grate, flex form, Sentre, and Trend systems. The sand barrels have the lowest initial cost but have the highest repair cost per impact. The Hydro cushion has a high initial cost, but repair costs are low to medium range.

Two new systems are going to be employed in 1987. They are the Sentre and Trend Systems. These systems, installed by the Department, have performed adequately and will continue to do so provided that the installation is done properly and that they are maintained properly and regularly. As stated, the systems presently in service are, in the most part, performing as designed, and are providing the motorist with the additional safety factor that was hoped for at the time of installation of these devices.

There have been no records obtained on the majority of the collisions with these devices, as the impact has not severely damaged the vehicle, and the vehicle was driven away from the scene without law enforcement agencies being notified. These devices are creating a negative financial impact on the Department in that there is no cost recovery when damage occurs.

#### NEEP NO. 5 - TRAFFIC CONTROL AND SURVEILLANCE

OBJECTIVE: Evaluation of more technologically advanced traffic control systems in heavily congested urban areas.

EXPERIENCE: The Department has a very extensive traffic control and surveillance program in the Metropolitan Seattle area. It consists of 95 electronic survey systems, 24 ramp meters and 20 miles of coverage by closed circuit TV. It also incorporates 6 variable message signs and 7 highway advisory

radio (HAR) transmitters. The Seattle system has saved the driving motorists 76,960 vehicle hours per year and has reduced the accidents at metered on-ramps by 30 percent. The Seattle system is highly sophisticated and does require highly trained personnel to operate it.

The savings to the motoring public warrants continued use of this system in the Metropolitan Seattle area. Other metropolitan areas would have to conduct a benefit analysis prior to taking on a similar sophisticated system. Other areas of the state have used various types of traffic control and surveillance measures. They range from the use of HAR radio for traffic control, for prewarning of problem areas in traffic, changeable message signs that provide advance warning for construction areas and for dangerous areas that are ahead of the motorist. Changeable message signs and the HAR system are also used for advance warning of snow conditions in the Cascade Mountain Passes.

Another traffic control device used is the reversible lane signing which provides a through traffic lane in the direction of the major traffic flow, to relieve the pressures on roadway systems.

#### NEEP NO. 6 - DIAGRAMMATIC SIGNING

OBJECTIVE: Determination of motorist's ability to react to more detailed diagram signs versus basis sign messages.

EXPERIENCE: The Department has limited the use of diagrammatic signing due to their complexity. Diagrammatic signing has been used effectively on left-hand turns, left-hand off ramps, freeway splits and complicated interchanges. The use of these signs should be limited to areas where the speed of the vehicle is reduced to allow the driver time to understand the sign. Subjective evaluations that have symbol signs, along with brief messages, are the best application of diagrammatic signing.

NEEP NO. 7 - PORTLAND CEMENT CONCRETE SHOULDERS

OBJECTIVE: Evaluate the practical aspects of Portland Cement Concrete shoulders versus other more commonly used types.

EXPERIENCE: Portland Cement Concrete (PCC) shoulders have been used at a few locations in the state. They appear to provide considerable benefit, in that they afford extra structural support to the edge of the pavement and allow easier maintenance of joint seals which prevent water penetration into the shoulders. Concrete shoulders have been used on the west side of Snoqualmie Pass and are providing reduced maintenance in this area.

NEEP NO. 8 - PROPER VIBRATION OF PORTLAND CEMENT CONCRETE (PCC) PAVEMENTS

OBJECTIVE: Study prompted by a strong national interest in the proper consolidation of pavement concrete. Finite results were not determined.

EXPERIENCE: The Department has not conducted any studies on this NEEP project.

NEEP NO. 9 - DESIGN AND CONSTRUCTION OF CONCRETE RAMPS

OBJECTIVE: Evaluation of uniform width concrete ramps. Project was initiated in response to urgings of concrete paving contractors.

EXPERIENCE: The Department does not construct concrete ramps because they are not cost effective, therefore, no studies have been conducted on this NEEP project.

NEEP NO. 10 - REDUCING REFLECTIVE CRACKING IN BITUMINOUS OVERLAYS

OBJECTIVE: Evaluation of methods, materials and practices which reduce reflection cracking in asphaltic concrete overlays. Included

were asphalt-rubber stress absorbing membrane interlayer (SAMI), fabrics, the Asphalt Institute Overlay Design, low viscosity asphalts, heater scarification, rubberized slurry seal, plant mix seals, slurry seals, bond breakers, and asphalt rejuvenating agents.

EXPERIENCE: A number of methods have been used to try and reduce reflective cracking in bituminous overlays have been used throughout the State. These methods are: various types of fabrics, rubberized slurry seals and cushioned course. To date, the only method that has been shown to be working effectively is the cushioned course. Through use of these various interlayers, it has been determined that the thicker ACP overlays perform better than the thinner overlays. Open-graded mixes seem to perform better than other ACP dense-graded mixes.

An experimental type mix, Plus-Ride, has also been evaluated and has shown limited success. To date, the best performing crack prevention projects have greater thickness of ACP or an addition of crushed surfacing cushion course as part of the pavement section. Thicknesses of the cover seems to be a key performance element of the crack prevention systems.

#### NEEP NO. 11 - DEVELOPMENT OF WATERTIGHT BRIDGE DECK JOINT SEALS

OBJECTIVE: Evaluation of a number of proprietary joint devices that are designed to prevent the deterioration of the structural members of bridges through joint leakage.

EXPERIENCE: The Department has tried a number of expansion joint seals, none of which has prevented leaking. This is due to the excess movement and/or deterioration of the joint materials. The installation and evaluation of a number of proprietary expansion joints devices has been conducted by the Bridge and Structures Office.

Their findings were that for large movement joints, multiple support bars are generally the most effective joint systems. They have found two promising single support bar systems and are presently evaluating them. For medium movement joints, the most effective system to date are strip seals with steel expansions. Compression seals are usually used for small movement joints. Evazote 50 is a material that is showing promise for small joints. The evaluation of this product is not complete at this time. A complete water-tight system has yet to be developed.

#### NEEP NO. 12 - BRIDGE DECK PROTECTIVE SYSTEMS

OBJECTIVE: Use and evaluation of methods and materials to mitigate the detrimental effects of deicing chemicals. Waterproofing membranes, polymer concretes, and low-slump dense concretes were predominant in the study.

EXPERIENCE: A number of systems and materials to protect the decks of bridges have been used by the Department. They are: waterproof membranes, Polymer concretes, low-slump concrete, latex modified concrete, Calcium Nitrite in precast concrete panels, wax beads, tapecrete and cathodic protection. To date, the systems that are performing best are waterproof membranes and latex modified concrete.

With all systems, the old deck must be prepared properly prior to placement of the protective system. If the contamination in the old deck is not completely removed, the deterioration will continue regardless of the type of overlay or protective system used. The structures that were overlaid with a waterproof membrane system shortly after construction have shown minimum corrosion to date. Cathodic protection systems used to date have shown progressive failure. This could be due to poor construction methods.

For best results in protecting the bridge deck, a viable protective system should be used. The best contractors available should do the construction and specified materials should be used rather than allowing for an equal product.

It has been noted that a number of the above protective systems are very sensitive to ambient conditions during the installation. This should be emphasized in the construction specifications and inspectors should control the installations to assure that they are placed under proper conditions.

#### NEEP NO. 13 - LONGITUDINAL CRACKING OF PORTLAND CEMENT CONCRETE PAVEMENTS

OBJECTIVE: Study prompted by survey which identified ten states reporting excessive random longitudinal cracking in PCC pavements. Common design elements were: use of polyethylene tape to form longitudinal joint; less than D/4 depth of weakened plane joint (D = slab thickness); and larger percentages of tricalcium aluminate present in their Type I cements.

EXPERIENCE: The Department has experienced only one problem with respect to longitudinal cracking. This occurred on a project on I-90 in District 5. The problem was caused by the polyethylene joint tape that was used to form the center line joints. It did not perform properly. The Department presently uses sawed joints and has found them to be satisfactory to date.

#### NEEP NO. 14 - DRAINAGE BLANKET IN HIGHWAY PAVEMENT SYSTEMS

OBJECTIVE: Evaluation of the design, construction and performance of a two-layer drainage course system for the control and rapid removal of ground water seepage and a drainage course system to accommodate water from precipitation and surface infiltration.

EXPERIENCE: Single and double layered blanket systems to convey water away from the pavement towards ditches or drainage systems have been installed by the Department. The use of a blanket must be carefully reviewed, as contamination of the system can reduce the effectiveness and possibly cause unwanted roadway damage.

NEEP NO. 15 - REDUCING THE SEASONALITY OF HOT PLANT MIX BITUMINOUS PAVING  
- REGION 15 DEMONSTRATION PROJECT NO. 9

OBJECTIVE: Demonstration of a method for extending the paving season for asphalt pavements. Method called for controlling the laydown temperature, pavement layer thickness, and time for breakdown compaction.

EXPERIENCE: The Department, as standard practice, does not encourage cold weather paving. It is felt that the extra thickness of the pavement layer and the amount of control required is too costly to warrant paving under cold weather conditions. The Department has constructed projects that have extended into colder temperatures and the failure rate of these projects has been markedly greater than pavements that were done during the warmer construction season.

NEEP NO. 16 - EPOXY COATED REINFORCING STEEL

OBJECTIVE: Evaluation of epoxy coated reinforcing steel in new bridge decks.

EXPERIENCE: The Department is now requiring the use of epoxy coating reinforcing steel in the top mat of all newly constructed bridge decks and approach slabs. It was noted that the epoxy steel, when cut, must be coated with epoxy in the field prior to the placement of the concrete.

NEEP NO. 17 - EVALUATION OF BREAKAWAY CABLE TERMINAL (BCT) FOR ROADSIDE  
GUARDRAIL WITH OTHER GUARDRAIL TERMINALS

OBJECTIVE: Evaluation of States experience with actual field installation of the BCT.

EXPERIENCE: There is an installation of BCT in District 4. This installation has been struck by a compact vehicle and has worked as designed. The collision at the District 4 site was a non-injury impact which tore away the BCT and two breakaway guardrail posts and bent the guardrail section in a manner that was not hazardous to the driver or the motoring public. It appears that this system is a good safety feature. The Department will be installing BCT's at other sites as the need arises.

NEEP NO. 18 - CATHODIC PROTECTION OF BRIDGE DECKS

OBJECTIVE: Promoted the use of cathodic protection in conjunction with Demonstration Project no. 34. Construction of most projects have been done under this Demonstration project.

EXPERIENCE: The Department has installed two cathodic protection systems. One was a grooved system and the other a grid placed on top of the bridge deck and overlaid with latex modified concrete (LMC). The grooved or slotted system was placed on the Woodinville Interchange and the grid system was placed on the Yakima River Bridge.

The cathodic protection at the ES ramp of the Woodinville Interchange structure involved sawing 3/4" by 3/4" grooves longitudinally in the existing deck on 1' centers. Wire was

placed in the grooves and then the grooves were filled with a conductive polymer filler. The wires were connected to the electric power supply. The wires were connected to the top mat of reinforcing steel and a source of electricity.

The Yakima River Bridge grid was attached to the top mat of reinforcing bar. The mat laid on top of the deck with anodes connected to the rebar. The mat was overlaid with latex modified concrete.

Both methods of cathodic protection have had various problems that are presently being investigated and solved. Future use of cathodic protection will depend on the effectiveness of the existing systems and the training of availability of properly trained system installers.

Cathodic protection systems used to date have shown progressive failure. This could be due to poor construction methods.

New anode systems are rapidly being developed and by the time the evaluation is completed on these two structures, new designs should be available that are superior to the systems that were placed under this Demonstration project.

It is very important that cathodic protection systems be maintained on a regular basis. Should this not be done, failures can be expected at a rapid pace.

#### NEEP NO. 19 - USE OF EMULSIFIED ASPHALTS IN BASE COURSE MIXTURES

OBJECTIVE: Promote the use of emulsified asphalts as binders in base construction. An acceptable mix design was never developed and the project was terminated.

EXPERIENCE: The Department has used emulsified asphalts and open-graded mix design on several projects throughout the state. The construction and life of these pavements have been very successful and the Department's present plans are to continue the use of this design for future roadways, as conditions permit.

NEEP NO. 20 - EXPERIMENTAL PAVEMENT CONSTRUCTION USING ECONOCRETE

OBJECTIVE: Experimental construction and evaluation of Econocrete. The construction involved, (a) two-course monolithic pavement constructed using Econocrete as a lower course and a minimum of 2 inches of standard, high quality PCC surface course, and (b) Econocrete base course surfaced with asphaltic concrete.

EXPERIENCE: The Department has not constructed any roadways using this material to date.

NEEP NO. 21 - NOISE INSULATION FOR PRIVATE DWELLINGS

OBJECTIVE: Evaluation of the performance and cost effectiveness of noise insulation measures applied to dwellings versus the construction of noise barriers.

EXPERIENCE: As a matter of policy, WSDOT declined to participate in this NEEP program. Noise insulation added to dwellings does not provide much abatement for the non air-conditioned dwellings because the majority have windows open during the summer months.

To date, the only dwellings that would benefit from added insulation for noise would be those that have air conditioning. The Department's position is that the best abatement is some type of barrier between the noise source and the dwelling.

## NEEP NO. 22 - PAVEMENT RECYCLING

**OBJECTIVE:** Evaluation of recycling methods and processes for both asphalt and Portland Cement Concrete (PCC) pavements.

**EXPERIENCE:** A number of asphalt recycling projects have been constructed throughout the state. Due to their success, and prior to the lower prices of petroleum, they were a cost effective process for reconstruction jobs. Since the petroleum prices have dropped, the cost of asphalt has been reduced and the use of recycling as a method for resurfacing pavements is not as desirable. Some of the contractors are still bidding on reclaiming the asphalt but they are stockpiling it and using it for private driveways and roads. This utilization of this material is cost effective for the Contractor and for the Department.

Washington does more asphalt pavement recycling than most states, and it has been a successful practice. Researchers have found that using recycling methods, instead of conventional asphalt paving, will save the state 37% in asphalt costs. This, of course, is dependent upon the price of the asphalt. To date, there is no information on recycling PCC.

## NEEP NO. 23 - HIGHWAY ADVISORY RADIO

**OBJECTIVE:** Evaluation of the performance of Highway Advisory Radio equipment in work zones.

**EXPERIENCE:** The Department's first use of Highway Advisory Radio (HAR) was at Snoqualmie Pass in the Cascade mountains, to provide information to the motorist about winter driving conditions. HAR, over the years, has proven to be very successful and barring minor problems at the time of installation, which have been solved, the system has been operating well.

The Department also uses HAR for providing advance notices to the motorist regarding roadway construction. The system requires presigning, indicating the radio station to be dialed for motorist information through construction sites, a tape recorder/player, and a transmitter for broadcasting taped messages. HAR has been very successful and the driving motorist has expressed appreciation of this type of communication.

The Department, based on past experiences, will continue using the HAR system for advising the motorist of problem areas on the highways. One of the pitfalls of this type of system is the use of continued repeated messages. Many comments have come from motorists and the State Patrol indicating that the messages are not timely and this is something that the Department will have to improve to ensure that as the conditions change they are noted in the radio message.

NEEP NO. 24 - USE OF INCENTIVE AND DISINCENTIVE PROVISIONS REGARDING QUALITY AND COMPLETION TIME FOR FEDERAL-AID HIGHWAY CONSTRUCTION

OBJECTIVE: Determine the effectiveness of incentive payments to contractors in terms of cost and ability to complete work satisfactorily in a shortened time frame.

EXPERIENCE: The Department has implemented the practice of providing bonuses to contractors when they beat deadlines and provide construction at lower than bid prices. Also implemented are provisions that would assess penalties to contractors that do not meet schedules, bid prices, or adhere to specifications. The use of this method of rewarding contractors has shown that contractors, as an average, have sped up the contract work without cause for inferior final products.

NEEP NO. 25 - CONCRETE OVERLAYS

OBJECTIVE: Determine design and construction procedures, structural properties, costs, and performance of Portland Cement Concrete (PCC) overlays placed on PCC pavements.

Iowa, California, New York, Louisiana, Wyoming, Texas, Wisconsin, South Dakota, Pennsylvania and Arkansas have constructed or are planning thin bonded projects.

EXPERIENCE: To date, there is no data on the Department's experience with concrete overlays on PCC pavements

NEEP NO. 26 - USE OF SULFUR AS AN EXTENDER TO ASPHALT IN HIGHWAY PAVEMENTS

OBJECTIVE: Evaluation of sulfur extended asphalt pavements.

EXPERIENCE: The Department, through a research project at the University of Washington, constructed sulfur asphalt pavement near Pullman, Washington. The paving has not deteriorated to any major degree after five-years of service. The only deterioration that has been noted is some rutting in the wheel tracks, caused by studded tires, and some pavement cracking, caused by exposure to the weather.

This process was being considered in the late 70's and early 80's as being a method to reduce the cost of paving due to high petroleum prices. Since the project, the petroleum prices have lowered and sulfur prices have increased, thus making it impractical and not economically feasible to construct pavements using sulfur as an asphalt extender. Sulfur Extended Asphalt may be considered as an alternative should the cost of petroleum materials rise to or above those costs seen in the 70's and early 80's.

## NEEP NO. 27 - CONCRETE JOINT RESTORATION AND REHABILITATION

OBJECTIVE: Obtain experience with a variety of joint rehabilitation techniques to restore load transfer between slabs, prevent the intrusion of material and water into and through the joint, reduce resultant cracking, and restore the existing PCC to high service condition without the use of an overlay.

EXPERIENCE: The most significant experience that the Department has had with joint sealers has been a project on Snoqualmie Pass. This project entailed the placement of three different joint sealers to determine which would perform the best.

It was noted that one of the sealers failed early due to installation problems and had to be reinstalled. All these sealants are performing satisfactorily at present. It was also noted that most joints sealed eventually allow moisture to seep through. Evaluation on this project is on-going and the results will be forthcoming.

## NEEP NO. 28 - HIGHWAY PAVEMENT SUBDRAIN SYSTEMS

OBJECTIVE: Obtain experience and data on the various types of drainage systems both for new construction and for 3-R type construction projects.

EXPERIENCE: The Department has installed slotted drains using course and crushed rock on Snoqualmie Pass in District 5. The installation was at a bridge end. The drain appears to be functioning properly as of this date.

Other pavement drain systems have been used by the Department. The French Drains or fabric-wrapped drains appear to improve conveying the water away from the roadway. The type of rock,

perforated pipe, wick-type drains and fabric used must be evaluated for a specific installation. Each installation is site specific. These drains are being placed under present construction contracts and will be evaluated and reported on in the future.