National Research Council

STRATEGIC HIGHWAY RESEARCH PROGRAM

SPECIFIC PAVEMENT STUDIES
EXPERIMENTAL DESIGN AND RESEARCH PLAN
FOR EXPERIMENT SPS-1
STRATEGIC STUDY OF STRUCTURAL FACTORS
FOR FLEXIBLE PAVEMENTS

STRATEGIC HIGHWAY RESEARCH PROGRAM
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(Supercedes the September 1989 Version)

SPECIFIC PAVEMENT STUDIES

EXPERIMENTAL DESIGN AND RESEARCH PLAN FOR EXPERIMENT SPS-1

STRATEGIC STUDY OF STRUCTURAL FACTORS FOR FLEXIBLE PAVEMENTS

INTRODUCTION

This report includes a revised experimental design for the Specific Pavement Studies experiment on SPS-1, "Strategic Study of Structural Factors for Flexible Pavements" that incorporates recommended changes. It is a refinement of the experiment on subdrainage proposed in the May 1986 SHRP Research Plans to include base and surface structural factors. It supercedes the preliminary report of September 1989.

The preliminary experimental design for the experiment was developed in cooperation with state and provincial highway agency personnel who participated in a study workshop held in Washington, D.C. June 19-20, 1989. It was included in the report, "Specific Pavement Studies: Experimental Design and Research Plan for Experiment SPS-1, Strategic Study of Structural Factors for Flexible Pavements", dated September 1989 that was forwarded to all highway agencies. Based on comments received, the experimental plan has been revised to increase the minimum asphalt surface thickness and thus extend the performance period for heavily trafficked sites, and to add test sections with different base thicknesses to enable better evaluation of the effect of base thickness and type.

This experiment, while being coordinated through SHRP, is being conducted for and by state and provincial highway agencies. Therefore, the details of the experiment have been selected to address the needs of the highway community. However, the experimental rigor necessary to achieve the desired results from this research requires that participating agencies agree to the same experimental factors and to construct the required test sections in a consistent manner.

While highway agencies are primarily concerned with problems and issues of a local nature, this experiment is designed as a nationwide experiment to fulfill basic needs of the highway pavement community at large. The statistical aspects of this experiment make the full cooperation of participating highway agencies crucial to its success. Hopefully, specific issues of local concern as well as innovative techniques can also be incorporated through the impetus and opportunities provided by this national study.

PROBLEM STATEMENT

Substantial progress has been made over the past century towards providing economical pavements. Pavement design procedures, construction techniques, and material specifications have been developed and refined as tools to aid engineers in design and management of highway pavement systems. While much has been learned in recent years, highway agencies need to know a great deal more to improve existing pavement design methods and the tools needed to effectively manage pavement networks.

At present, highway agencies lack sufficient information on the influence of pavement drainage on the performance of flexible pavements. There is little quality experimental field data to quantify its influence or effect on performance.

Currently, the influence of drainage is incorporated into the AASHTO Guide for Design of Pavement Structures through a modified structural number concept using qualitative descriptions to guide selection of the layer modification coefficients. As stated in Volume II, Appendix DD of the AASHTO Guide, coefficients were developed through a theoretical approach because very little field data existed.

Flexible pavement design and evaluation developments in the past 20 years have concentrated on modeling the pavement structure as an elastic multilayered system. The layers are characterized by their thickness, modulus of elasticity (stiffness), and Poisson's ratio with layer thickness and elastic modulus or stiffness being most important. Highway agencies lack information on the interaction of these key factors with other variables such as climate. Therefore controlled field experiments are necessary to answer the following questions:

To what extent does the influence of pavement drainage on pavement performance vary from wet to dry climatic zones and what is the relative importance in each zone?

To what extent does asphalt concrete thickness, type or thickness of the base layer influence pavement performance and what is the relative importance of each? How do environmental factors influence the relative importance?

The General Pavement Studies (GPS) experiments on flexible pavements GPS-1, "Asphalt Concrete Pavements on Granular Bases" and GPS-2, "Asphalt Concrete Pavements on Bound Bases", which are limited to pavements constructed since 1970, deal with some of the issues addressed by this study. However, the GPS experiments will only provide a limited precision due to the uncertainties in historical data and lack of experimental control over some key variables that influence pavement performance. The most critical unknown in GPS research is the traffic loading applied at each test section since construction. Other historical factors such as special events (rainstorms) or problems during the construction of the GPS sections are not uniformly known. Although as many constraints as feasible were applied to selection of GPS test sections, some important factors such as age of the test section, shoulder type, and drainage features are not systematically controlled. Although GPS will provide valuable and timely information, controlled SPS studies of newly constructed pavement sections are needed to provide an accurate estimate of the relative influence of key pavement elements that affect pavement performance. The importance of this experiment is highlighted by its ability to evaluate the interaction of drainage, structural parameters, and climatic factors on pavement performance in a controlled manner.

OBJECTIVE

The objective of this study is to more precisely determine the relative influence of strategic factors that influence the performance of flexible pavements. The factors addressed in this study include drainage, base type and thickness, and asphalt surface thickness. The study objective includes a determination of the influence of environmental region and soil type on these factors. Accomplishing this objective will provide substantially improved tools for use in the design and construction of new and reconstructed flexible pavements.

PRODUCTS

Some of the products of this experiment will help accomplish the objectives of the SHRP Long Term Pavement Performance program as stated in the May 1986 Final Report on the Strategic Highway Research Program Research Plans. The key products from the proposed study will include:

1. Evaluation of existing design methods.
2. Development of improved design equations for new and reconstructed pavements.
3. Determination of the effects of specific design features on pavement performance.
4. Development of a comprehensive data base for use by state and provincial engineers and other researchers.

Development of the national pavement data base is the vehicle or tool to expedite the analyses needed to produce the other products. This data base will permit centralized and efficient distribution of massive quantities of data to participating highway authorities, researchers, and other interested parties.

The AASHTO Guide for Design of Pavement Structures is representative of current pavement design methods. It is used in the following discussion to demonstrate the type and nature of products that can be developed from this experiment. However, other design methods or performance equations can be evaluated or improved using similar types of analysis and the extensive data base that will be developed from this study.

The data produced by this experiment will be used to evaluate existing design methods and performance equations. The AASHTO basic design equation for flexible pavements can be evaluated by comparing observed serviceability index (derived from profile and distress measurements on each test section) against that predicted by the design equation. All of the inputs concerning the pavement structure, traffic, environment, drainage and material properties will be quantified. Additionally, this experiment will permit the variability associated with each of the inputs to be quantified and allow evaluation of the reliability aspects of the model.

The data from this experiment can be used to develop or improve pavement design methods. For example, the findings on the influence of climate may permit a more accurate quantification of climate influences directly into an empirical design model.

Further development of more fundamental models, sometimes referred to as "mechanistic" models can be achieved through controlled experimentation. For example, these models can be further developed through improvements in the empirical relationships between mechanistic formulated variables (responses) and measures of pavement distress (such as rutting, cracking, etc.) or through field studies of pavement responses.

An example of an empirical relationship is the relationship between the computed horizontal tensile strain in the bottom of the asphaltic concrete layer and the development of fatigue cracks as used in the Shell Research and Asphalt Institute design models. In these types of models, theoretical based variables, such as computed stress or strains, are related to measures of distress through regression analysis. Improvement of the empirical portions of these models will greatly improve their reliability and usefulness in both the design of new pavement and evaluation of existing pavements.

An alternative to improving the empirical portion of mechanistic-empirical models, is the improvement, validation or calibration of the mechanistic portion of the model through field studies of pavement responses. This type of research requires measurement of key pavement responses, such as deflections and strains through in-pavement instrumentation and site specific measurements of axle loads and climatic variables. It provides a basis for evaluating theoretical response models, studying the relationship between theoretical material characterizations and materials test results, and the influence of environment on changes in material properties over time, and requires the instrumentation of selected test sites to obtain the necessary data.

The proposed experimental design is aimed directly at determining the effects of the following specific pavement design features:

1. In-pavement drainage system.
2. Base type.
3. Base thickness.
4. Pavement thickness.

The interaction of these factors will be determined in combination with the effect of environmental region and soil type. The effects of these factors will be studied under realistic performance conditions with significant materials and construction control. This experiment will add significantly to the understanding of the long-term performance of flexible pavements with asphaltic concrete surfaces.

BENEFITS TO PARTICIPATING HIGHWAY AGENCIES

While all highway agencies will benefit from the information, knowledge and products that result from this research, participating agencies will accrue additional direct benefits. Since a portion of this research will be conducted in an agency's jurisdiction on test sections constructed using materials and techniques employed by that agency and exposed to local climate and truck loadings, participating agencies will be able to make direct use of the results. Test sections within an agency's jurisdiction will also allow that agency an opportunity to directly relate their pavement monitoring and performance evaluation methods to those employed by SHRP. For instance, an agency that usually uses a Dynaflect or Roadrater deflection measuring device can develop correlations with the falling weight deflectometer measurements performed using SHRP equipment.

INNOVATION

Sponsoring agencies have the opportunity to expand the experiment to address some of their own interests and concerns as well as incorporate innovative technology. For example, agencies interested in evaluating modified asphalts could construct additional test sections near the SHRP test sections and directly compare their performance to that of the basic experimental test sections. This approach provides participating agencies the opportunity to conduct intensive pavement field research relatively economically by taking advantage of the research infrastructure established for the SHRP study.

SHRP encourages the construction of supplemental test sections and is prepared to assist interested agencies in the experimental design, data collection, and performance evaluation of such supplemental experiments. Further, if a group of participating agencies desire to join together in such activity, SHRP is also prepared to work with these states and/or provinces to coordinate a multi-state/provincial supplemental experiment. The section of this report, "Ideas for Extension of Experiment by Participating Highway Agencies," identifies potential areas for further study in the experiment.

In addition to these direct benefits, participating agencies will also receive ancillary benefits as a result of direct involvement in the experimental process including valuable insights and exchange of ideas through interaction with the SHRP team, researchers and highway personnel from other agencies.

EXPERIMENTAL DESIGN

Table 1 depicts a refined experimental design for this experiment that incorporates input from state and provincial highway agencies and other interested parties. The study factors are grouped into structural factors that relate to the surface and base, and site factors that relate to the climate and subgrade.

Table 1. Experiment design for SPS-1.

PAVEMENT STRUCTURE COMBINATIONS				FACTORS FOR MOISTURE, TEMPERATURE, SUBGRADE TYPE, AND LOCATION															
				WET								DRY							
				FREEZE				NO FREEZE				FREEZE				NO FREEZE			
				FINE		COARSE		FINE		COARSE		FINE		COARSE		FINE		COARSE	
DRAINAGE	BASE TYPE	TOTAL BASE THICK	SURFACE THICK	J	K	L	M	N	O	P	Q	R	S	T	U	V	W	X	Y
NO	AGG	8"	4"		K1		M1		O1		Q1		S1		U1		W1		Y1
			7"	J1		L1		N1		P1		R1		T1		V1		X1	
		12"	4"	J2		L2		N2		P2		R2		T2		V2		X2	
			7"		K2		M2		O2		Q2		S2		U2		W2		Y2
	ATB	8"	4"	J3		L3		N3		P3		R3		T3		V3		X3	
			7"		K3		M3		O3		Q3		S3		U3		W3		Y3
		12"	4"		K4		M4		O4		Q4		S4		U4		W4		Y4
			7"	J4		L4		N4		P4		R4		T4		V4		X4	
	ATB / 4"AGG	8"	4"	J5		L5		N5		P5		R5		T5		V5		X5	
			7"		K5		M5		O5		Q5		S5		U5		W5		Y5
		12"	4"		K6		M6		O6		Q6		S6		U6		W6		Y6
			7"	J6		L6		N6		P6		R6		T6		V6		X6	
YES	PATB / AGG	8"	4"	J7		L7		N7		P7		R7		T7		V7		X7	
			7"		K7		M7		O7		Q7		S7		U7		W7		Y7
		12"	4"		K8		M8		O8		Q8		S8		U8		W8		Y8
			7"	J8		L8		N8		P8		R8		T8		V8		X8	
		16"	4"		K9		M9		O9		Q9		S9		U9		W9		Y9
			7"	J9		L9		N9		P9		R9		T9		V9		X9	
	ATB / PATB	8"	4"		K10		M10		O10		Q10		S10		U10		W10		Y10
			7"	J10		L10		N10		P10		R10		T10		V10		X10	
		12"	4"	J11		L11		N11		P11		R11		T11		V11		X11	
			7"		K11		M11		O11		Q11		S11		U11		W11		Y11
		16"	4"	J12		L12		N12		P12		R12		T12		V12		X12	
			7"		K12		M12		O12		Q12		S12		U12		W12		Y12

AGG = Dende-graded untreated aggregate base
ATB = Dense-graded asphalt treated base
PATB = 4" thick open-graded permeable asphalt-treated drainage layer, underneath ATB or over AGG base
4" AGG = 4" thick dense-graded untreated aggregate base layer underneath ATB

STATISTICAL EXPERIMENTAL DESIGN ASPECTS

The full factorial for this experiment, as shown in Table 1, contains 192 factor level combinations. In this table, the eight environmentally-related (soil and climate) combinations are shown across the top and the 24 pavement structure combinations are shown along the left side. The construction of 24 test sections at each site would require a greater effort on the part of the participating agencies. Therefore, the experiment has been developed so that only 50% of the possible combinations of factors, i.e. 12 test sections, will be built at each site. This approach offers a significant reduction in cost to participating agencies and enhances implementation practicality with no significant loss of precision.

TEST SITE/TEST SECTION COMBINATIONS

As shown in Table 1, each of the 192 test site/test section combinations included in the experiment is indicated by a cell containing a letter-number code. The letter denotes one of 16 test sites (J through Y) where a test section is to be constructed, while the number designates one of twelve test sections that are to be constructed at each site.

As can be seen in the table, 48 test sections representing all structural factor and subgrade type combinations are to be constructed in each of the four climatic regions, with 24 test sections to be constructed on fine-grained subgrade and 24 test sections on coarse-grained soil. Further, for each climate-soil combination, one-half of the 24 test sections are to be constructed at one test site and one-half are to be constructed at another site in the interest of implementation practicality. While it would be desirable to have these two sites located in different states and/or provinces, it is not absolutely necessary. However, if the two test sites are located in the same state or province, the two sites would preferably be located on different projects.

STATISTICAL IMPLICATIONS

As shown in Table 1, the set of 24 test sections that are to be constructed in each climatic-soil region is divided into two different subsets, each of which consists of twelve test sections. Subsets with similar test sections are to be constructed in each of the eight climatic-soil regions. Each subset of twelve test sections contains a number of sections at each level of each of the four structural factors. For example, each of six sections will have a thin asphalt surface and each of the other six sections will have a thick asphalt surface. Also each of five sections will have a thin base, each of other five sections will have a thick base and each of the remaining two sections will have a thicker base. Differences among mean values (of distress and performance) for each group of eight similar test sections can therefore be used to evaluate the effects of moisture (Sites J through Q versus Sites R through Y), temperature (Sites J through M and R through U versus sites N through Q and V through Y), soil type (Sites J, K, N, O, R, S, V, W versus Sites L, M, P, Q, T, U, X, Y), and the interactions among these three factors. Mean differences between the two sites in each of the eight columns of Table 1 (e.g. between Sites J and K) can statistically be regarded as chance variations between similar test sites for each of the eight climate-soil combinations and thus provide a basis for the assessment of experimental error.

To achieve the goals of the proposed experimental design, twelve sections would have to be constructed at each of sixteen sites, preferably located in different states and/or provinces.

SITE RELATED FACTORS

Site related factors include traffic, 4 climatic regions (wet-freeze, wet-no freeze, dry-freeze, dry-no freeze), and two subgrade soil types (fine and coarse).

Traffic

Traffic, while a major factor, is not controlled as a multi-level design factor in the experiment. Instead, traffic will be addressed as part of the test site selection process. An eligible test site candidate must have a minimum estimated traffic loading of 100,000 ESAL/year (Equivalent Single Axle Loads) on the outside lane. Traffic will vary from site to site and will therefore, be a co-variable in the study. The actual site specific traffic loading will be monitored through permanently installed weigh-in-motion (WIM) equipment with automatic vehicle classification capability.

Climatic Factors

The climate factor levels for this experiment are the same as those for the GPS experiments. The wet climatic regions include locations that have a high potential for moisture in the entire pavement structure throughout most of the year, while dry climatic regions include areas that have very little and low seasonal fluctuation of moisture in the pavement structure. The freeze climatic regions include locations with severe winters that result in long-term freezing of the subgrade, while no freeze climatic regions include areas that do not have long-term freezing of the subgrade.

Site specific climatology data is necessary and may require installation of a local weather station to collect the necessary information. However, if the site is located in close proximity to an existing weather station, then a site specific weather station would not be needed.

Soil Factor

The subgrade factor levels for this experiment of fine and coarse are the same as those for the GPS experiments.

STRUCTURAL FACTORS

The proposed experimental design includes 3 sets of multi-level structural factors for base/subbase and a two-level structural factor for surface thickness.

Base Structural Factors

The 3 sets of factors for base/subbase are base type (aggregate, asphalt-stabilized, and combination), base thickness (2 levels for the undrained sections and three levels for the drained sections) and drainage (yes and no).

Base Type. The base types selected for the study are dense-graded asphalt-stabilized (bound), dense-graded untreated aggregate (unbound), and combinations of dense-graded asphalt-stabilized, dense-graded untreated aggregate, and open-graded asphalt-stabilized materials.

For the undrained pavement sections, the asphalt-stabilized base is to be a plant hot-mixed, "high-quality," dense-graded base utilizing a stone with a top size not less than 1 inch. Similarily, the untreated aggregate base is to be "high quality" dense-graded, crushed stone base as used by the agency.

Each agency should design the bases using the agency's own mix design methods and standard specifications. However, the methods and procedures to be used to design these mixtures should be submitted to SHRP for review and approval. The final mix designs and the details of the designed mixes should also be submitted to SHRP.

For the drainable pavement sections, an open-graded (permeable) asphalt stabilized layer will be incorporated into the base structure of the pavement as part of the drainage system. This layer's contribution to the overall strength of the pavement structure (total structural number) will be considered equivalent to that of an equal thickness of the dense-graded unbound base material. A further description of the drainage layer material is provided in the section of the report entitled, "Drainage."

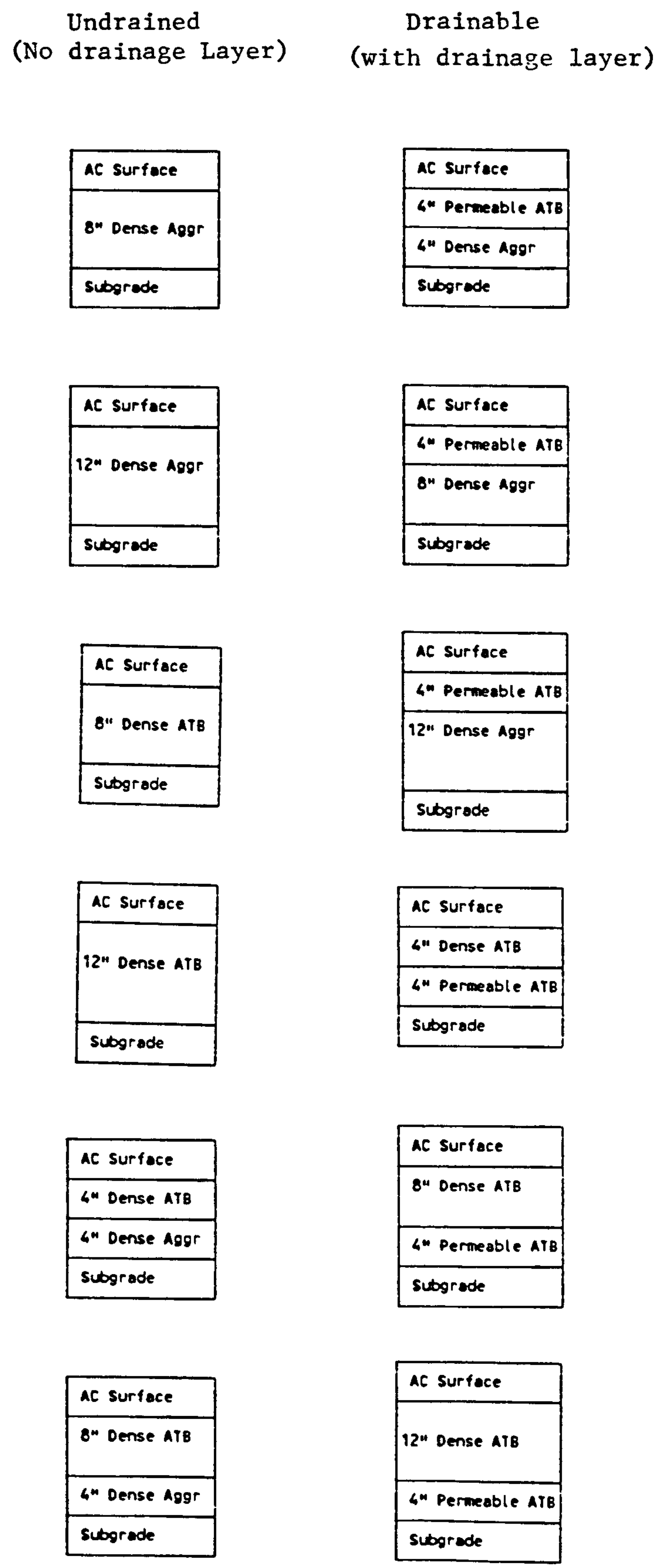
Base Thickness. In spite of the difference in traffic at test sites, uniform levels of base thicknesses are required at all test sites. Base thickness levels have been set at 8 and 12-inches for the undrained pavement sections, and at 8, 12, and 16 inches for the drained pavement sections. These thickness levels represent the total combined thickness of the base structure, including that of the drainage layer where applicable.

In addition, to evaluate the performance of pavement structures with the same relative magnitude of base strength for the drained and undrained pavements, certain combinations of base types and thicknesses are included. For this purpose, it is assumed that the unbound dense-graded aggregate base material has approximately the same structural value (structural coefficient) as the asphalt-treated open-graded permeable base proposed as the drainage layer. Therefore, some undrained pavement sections will incorporate a 4-inch thick dense-graded aggregate base layer in place of the 4-in. thick permeable layer to produce a pavement structure with an equivalent base strength. The combinations of base layer thicknesses for the drained and undrained test sections are illustrated in Figure 1.

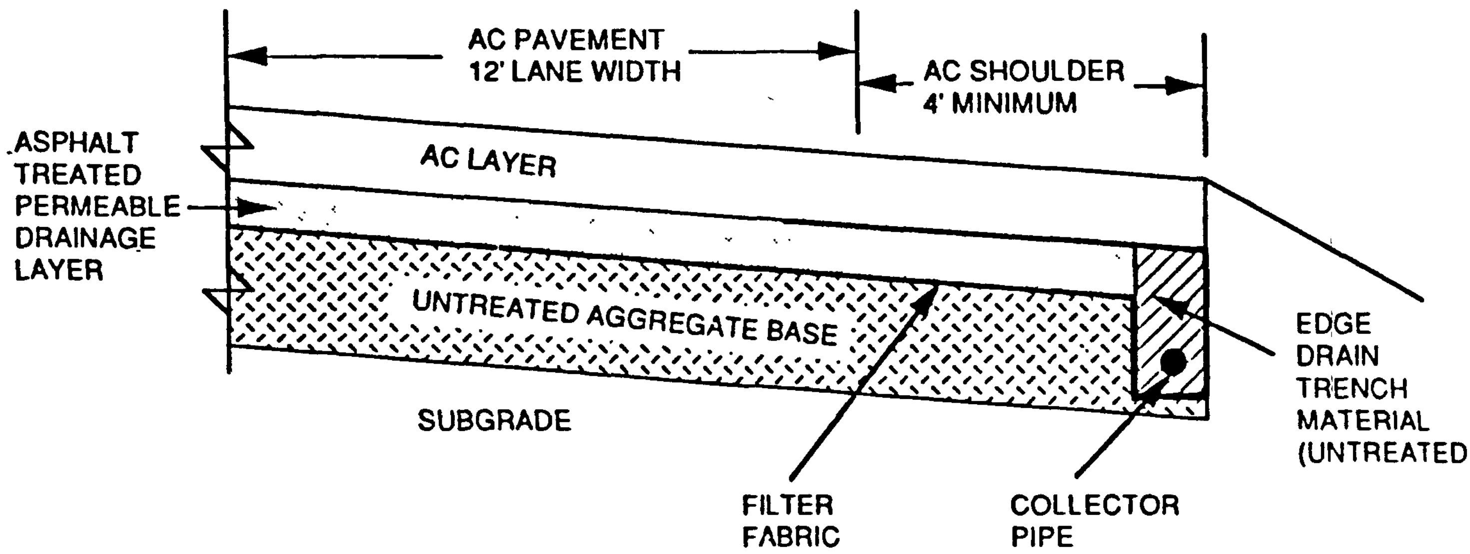
The variation in base thicknesses in conjunction with variations in surface thickness will result in different pavement design lives at the different sites, depending on traffic levels and environmental impacts. This highlights the need for accurate traffic data that must be collected through a permanent WIM station at each site.

Drainage. The drainage factor includes two levels represented by the presence or absence of an in-pavement drainage system. Drainable test sections will incorporate a drainage system that consists of a highly permeable (> 20,000 ft/day) asphalt-treated drainage layer extending the full width of the pavement to the outside edge of the shoulder, a fabric filter material, and a fabric wrapped longitudinal edge drain collector system as shown in Figure 2. Neither permeable layer nor longitudinal edge drains will be provided in the non-drained sections.

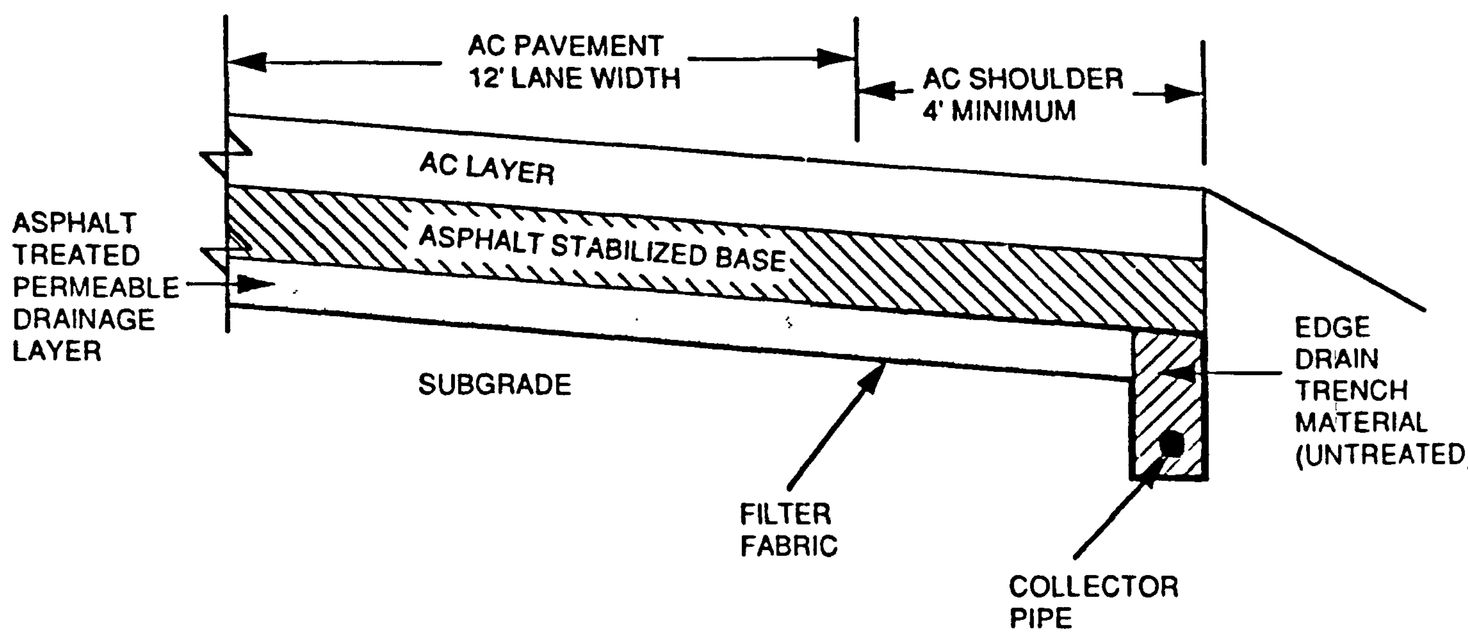
The permeable drainage layer to be incorporated in the pavement structure will consist of a 4-inch thick asphalt-treated open-graded material meeting the gradation proposed in Table 2. This layer should extend across all pavement lanes and the shoulder. At the edge of the shoulder, this treated layer interfaces with an edge drain and trench containing an untreated open graded granular material as shown in Figure 2.



Figuere 1. Base structure material and thickness combinations



A. Pavement drainage layer on section with dense untreated aggregate base.



B. Pavement drainage layer on section with dense asphalt stabilized base.

Figure 1. Illustration of pavement drainage system details.

Table 2. Gradation for asphalt treated permeable base.

Sieve Size	Percent Passing
1 1/2-inch	100
1-inch	95 - 100
3/4-inch	-
1/2-inch	25 - 60
3/8-inch	-
No. 4	0 - 10
No. 8	0 - 5
No. 10	0 - 2
Coefficient of Permeability (feet/day)	20,000

Location of the permeable layer within the pavement structure depends on base type. As shown in Figure 1, the permeable drainage layer should be placed beneath the lowest "bound" layer in the pavement structure. Thus, for pavement sections with an untreated dense graded base layer, the permeable drainage layer should be placed below the asphalt surface, i.e. on top of the untreated base. However, for sections with a dense graded asphalt stabilized base layer, the permeable base layer should be placed below the treated base.

Also as shown in Figure 2, it is recommended that a fabric filter material be used to prevent intrusion of fines into the permeable drainage materials. These filter materials must be designed for each site considering the relative gradations of materials at the interface between the drainage layer and untreated layer. SHRP will provide guidelines for the design of these material and sample specifications for their procurement. The use of this filter fabric should not serve as a proprietary product evaluation test. Each fabric will be designed to site conditions and specified to allow use of materials meeting the specifications. The same filter fabric should be used beneath the treated drainage layer and in the edge drain trench.

A filter fabric has been chosen over a graded sand filter layer to avoid constructing pavement structures with unequal base thicknesses due to the sand filter layer. To be properly applied, a graded sand filter layer would have to be designed for each site to allow a proper transition in gradation from the subgrade or underlying base material to the drainage layer. Consequently, filter layers of unequal thicknesses would be required at the different sites due to the difference in gradation between the underlying material and the drainage layer. Therefore, the use of a filter fabric is specified to provide the filter function and prevent intrusion of fines into the drainage layer without adding a layer of granular material.

In the transition zone from a drained to an undrained section, a transverse collector system may be incorporated into the drainage layer to intercept all water within the drainage layer and move it to the outside edge of the pavement structure. The details of this transverse drainage structure each site.

could be similar to that of the edge drain (trench with drain pipe). Details and need for a transverse drainage interceptor will depend on site conditions.

Pavement Surface Structural Factor

Pavement thickness is the only experimental factor for the asphaltic concrete layer. It will be uniformly varied across all sites at two levels. The low and high levels for the thickness of the asphalt concrete layer are 4 and 7 inches. This represents the combined thickness of the asphalt concrete surface layer (sometimes called the wearing course) plus the binder course.

The asphalt concrete should use local materials and be designed using participating agencies' typical design procedures and the guidelines contained in the FHWA Technical Advisory T5040.27, "Asphalt Concrete Mix Design and Field Control," March 10, 1988. The goal is to achieve reasonably consistent dense graded asphalt concrete mixes constructed from locally available materials. Details of mix design methods and procedures, as well as results of the specific mixes designed for SHRP test sections should be submitted to SHRP for review.

The stiffness of the asphalt concrete is not included as a design factor in the experiment due to the lack of an appropriate method for achieving uniform levels of stiffness during construction on a national basis. However, the stiffness of the mixes will be measured, documented, and treated as a co-variate in analyzing the study's data.

TEST SECTION CONFIGURATION AND CONSTRUCTION CONSIDERATIONS

The test pavements may be built either as part of a new or reconstructed roadway or as a parallel test road. If part of a reconstructed roadway, the reconstruction must include all lanes. In all cases the cross section must be uniform. Pavement widening projects are suitable only if all the test sections at a test site are part of the widening project and all lanes are reconstructed to achieve a uniform pavement cross section at all test sections. Construction of the test sections in a lane which is added to an existing pavement are not suitable for this experiment because of the difficulty of discerning the relationship of distresses developed in the existing lanes and those developed in the widened test sections.

Figure 3 illustrates a conceptual test site layout. The experimental design requires a minimum test section length of 600 feet. This will enable the drilling and sampling operations to be performed outside of the 500-ft. monitoring length. Transition sections are required between test sections. The length of these transitions depends on site conditions, such as locations of cut and fills, drainage structures, utilities, etc., but a minimum transition length of 100 feet should be provided between test sections.

Ideally, all test sections should be placed on shallow fill sections. While test sections may be built on cut or fill, no test section should be built on a cut/fill transition or on side hill fills.

Shoulders

Shoulders should have the full pavement structure across their width, i.e. the structural layers in the shoulder should match those of the outside lane. Shoulder width should be at least 4 feet.

Crown

Crowned and non-crowned (constant cross-slope) pavement cross sections can be constructed. On crowned sections, an additional longitudinal edge drain should be constructed on the inside the shoulder, similar to that constructed on the outside shoulder.

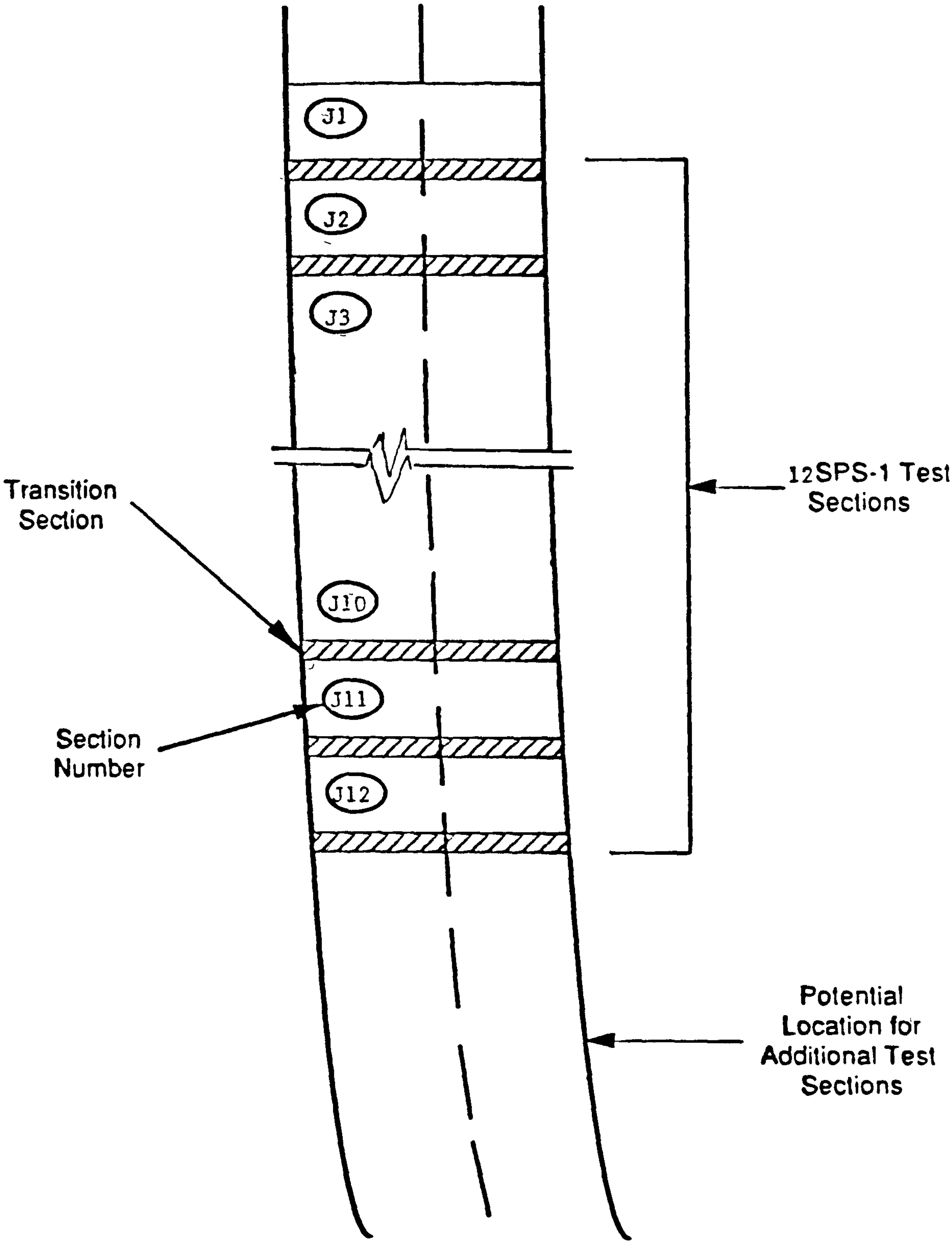


Figure 3. Schematic layout for test sections at Site J

IDEAS FOR EXTENSION OF EXPERIMENT BY PARTICIPATING HIGHWAY AGENCIES

Most highway agencies probably do not normally build flexible pavements with the combinations or types of asphalt, base and drainage system recommended in this experiment. Agencies participating in this experiment are urged to consider construction of additional experimental sections to evaluate innovative features of local or regional interest in addition to those required. For example, supplemental sections can be constructed as a part of the test site to evaluate the following materials or features:

* Alternate drainage methods.
* Soil cement, non-conforming aggregate bases, pervious concrete bases, or stabilized bases.
* Special modified asphalt cements.
* Recycled asphalt concrete materials.
* Geotextiles.
* Staged constructed test sections.
* Full depth shoulders.

PARTICIPATING HIGHWAY AGENCY RESPONSIBILITIES

Participating highway agencies play the key role in the development, construction and conduct of the Specific Pavement Studies, including the following activities:

* Participation in experiment and implementation plans.
* Nomination of test sites.
* Preparation of plans and specifications.
* Selection of construction contractors.
* Development of mixture designs.
* Materials testing to characterize in-place materials.
* Construction of test sections.
* Construction control, inspection, and management.
* Installation and operation of weigh-in-motion equipment and submission of traffic and load data.

* Installation and operation of in-pavement instrumentation and reporting of data on a limited number of test sections.
* Provision of traffic control for all test site data collection.
* Material sampling and testing.
* Collecting and reporting of as-built construction data.
* Conducting and reporting of periodic skid resistance.
* Conducting and reporting maintenance activities.
* Collecting and reporting of weather data.

SHRP RESPONSIBILITIES

The primary role of SHRP is to provide coordination and technical assistance to participating highway agencies to help insure uniformity and consistency in construction and data collection to achieve the desired study results. Some of the activities the SHRP team will be responsible for include:

* Development of experimental design.
* Coordination among participating agencies.
* Final acceptance of nominated test sites.
* Development of uniform data collection guidelines and forms.
* Coordination of materials sampling and testing.
* Monitoring of pavement performance.
* Development and operation of comprehensive database and data entry.
* Control of data quality.
* Data analysis and reporting.
* Review of material mix designs and construction plans.

IMPLEMENTATION AND SCHEDULE

This SPS-1 research plan and experimental design is ready for implementation. However, its development was an evolutionary process and refinements may be required as experience is gained from early projects.

The initial step in the implementation of this experiment is the identification and submission by highway agencies of candidate projects for possible inclusion in the study. A total of 16 projects, 4 in each climatic region, will be required to complete the experiment as planned. It is anticipated that only a few SPS-1 projects will be built during the 1990 construction season. The remaining test sites will be selected from the identified candidates scheduled for construction in 1991, or even 1992 if necessary. To assist the highway agencies in identifying candidate projects, guidelines for nominating and evaluating candidate projects for this experiment will be described in detail in a separate report. This report will include nomination forms, identify project selections criteria, and outline highway agency participation requirements.