

NATIONAL COOPERATIVE HIGHWAY RESEARCH PROGRAM
SYNTHESIS OF HIGHWAY PRACTICE

28

**PARTIAL-LANE
PAVEMENT WIDENING**

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PARTIAL-LANE PAVEMENT WIDENING

RESEARCH SPONSORED BY THE AMERICAN
ASSOCIATION OF STATE HIGHWAY AND
TRANSPORTATION OFFICIALS IN COOPERATION
WITH THE FEDERAL HIGHWAY ADMINISTRATION

AREAS OF INTEREST:
PAVEMENT DESIGN
CONSTRUCTION

TRANSPORTATION RESEARCH BOARD
NATIONAL RESEARCH COUNCIL
WASHINGTON, D.C. 1975

NATIONAL COOPERATIVE HIGHWAY RESEARCH PROGRAM

Systematic, well-designed research provides the most effective approach to the solution of many problems facing highway administrators and engineers. Often, highway problems are of local interest and can best be studied by highway departments individually or in cooperation with their state universities and others. However, the accelerating growth of highway transportation develops increasingly complex problems of wide interest to highway authorities. These problems are best studied through a coordinated program of cooperative research.

In recognition of these needs, the highway administrators of the American Association of State Highway and Transportation Officials initiated in 1962 an objective national highway research program employing modern scientific techniques. This program is supported on a continuing basis by funds from participating member states of the Association and it receives the full cooperation and support of the Federal Highway Administration, United States Department of Transportation.

The Transportation Research Board of the National Research Council was requested by the Association to administer the research program because of the Board's recognized objectivity and understanding of modern research practices. The Board is uniquely suited for this purpose as: it maintains an extensive committee structure from which authorities on any highway transportation subject may be drawn; it possesses avenues of communications and cooperation with federal, state, and local governmental agencies, universities, and industry; its relationship to its parent organization, the National Academy of Sciences, a private, nonprofit institution, is an insurance of objectivity; it maintains a full-time research correlation staff of specialists in highway transportation matters to bring the findings of research directly to those who are in a position to use them.

The program is developed on the basis of research needs identified by chief administrators of the highway and transportation departments and by committees of AASHTO. Each year, specific areas of research needs to be included in the program are proposed to the Academy and the Board by the American Association of State Highway and Transportation Officials. Research projects to fulfill these needs are defined by the Board, and qualified research agencies are selected from those that have submitted proposals. Administration and surveillance of research contracts are responsibilities of the Academy and its Transportation Research Board.

The needs for highway research are many, and the National Cooperative Highway Research Program can make significant contributions to the solution of highway transportation problems of mutual concern to many responsible groups. The program, however, is intended to complement rather than to substitute for or duplicate other highway research programs.

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PREFACE

There exists a vast storehouse of information relating to nearly every subject of concern to highway administrators and engineers. Much of it resulted from research and much from successful application of the engineering ideas of men faced with problems in their day-to-day work. Because there has been a lack of systematic means for bringing such useful information together and making it available to the entire highway fraternity, the American Association of State Highway and Transportation Officials has, through the mechanism of the National Cooperative Highway Research Program, authorized the Transportation Research Board to undertake a continuing project to search out and synthesize the useful knowledge from all possible sources and to prepare documented reports on current practices in the subject areas of concern.

This synthesis series attempts to report on the various practices without in fact making specific recommendations as would be found in handbooks or design manuals. Nonetheless, these documents can serve similar purposes, for each is a compendium of the best knowledge available concerning those measures found to be the most successful in resolving specific problems. The extent to which they are utilized in this fashion will quite logically be tempered by the breadth of the user's knowledge in the particular problem area.

FOREWORD

*By Staff
Transportation
Research Board*

This synthesis will be of special interest and usefulness to highway design and construction engineers and others who become involved in the use of partial-lane widening in upgrading existing pavements. Detailed information is offered on planning and programming practices, on design considerations, and on construction techniques that have proven successful in partial-lane widening projects.

Administrators, engineers and researchers are faced continually with many highway problems on which much information already exists either in documented form or in terms of undocumented experience and practice. Unfortunately, this information often is fragmented, scattered, and unevaluated. As a consequence, full information on what has been learned about a problem frequently is not assembled in seeking a solution. Costly research findings may go unused, valuable experience may be overlooked, and due consideration may not be given to recommended prac-

tices for solving or alleviating the problem. In an effort to resolve this situation, a continuing NCHRP project, carried out by the Transportation Research Board as the research agency, has the objective of synthesizing and reporting on common highway problems—a synthesis being identified as a composition or combination of separate parts or elements so as to form a whole greater than the sum of the separate parts. Reports from this endeavor constitute an NCHRP report series that collects and assembles the various forms of information into single concise documents pertaining to specific highway problems or sets of closely related problems.

Partial-lane pavement widenings, usually placed to serve with the adjoining old pavement as bases for structural overlays, have been employed for many years in pavement rehabilitation and betterment. Where the vertical and horizontal alignments of the older pavements are within the range of present standards, and only the widths have become obsolete, this approach to serving modern traffic has ample economic justification. Developing shortages of satisfactory construction materials provide further reason for adopting this type of improvement. The selection of adequate structural designs and the use of proper construction techniques for partial-lane widenings are important, and numerous failures have occurred when good practice has not been observed. Other considerations not directly related to the widening structure, but which nevertheless demand careful attention for over-all success, include such items as drainage changes and the provisions that must be made during construction for access to private and business properties served by the existing pavement.

This report of the Transportation Research Board records and evaluates current practices in the use of partial-lane pavement widening, and presents guidelines that past experience suggests will produce satisfactory results in most instances. The numerous problems that are likely to be encountered are pointed out and specific solutions are offered.

To develop this synthesis in a comprehensive manner and to ensure inclusion of significant knowledge, the Board analyzed available information assembled from many highway departments and agencies responsible for highway planning, design, construction, operations, and maintenance. A topic advisory panel of experts in the subject area was established to guide the researchers in organizing and evaluating the collected data, and to review the final synthesis report.

This synthesis is an immediately useful document that records practices which were acceptable within the limitations of the knowledge available at the time of its preparation. Meanwhile, the continuing process of search for better methods should go on undiminished.

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Adrian G. Clary, Engineer of Maintenance, and Lawrence F. Spaine, Engineer of Design, both of the Transportation Research Board, assisted the Special Projects staff and the Topic Advisory Panel.

Information on current practice was provided by many highway agencies, contractors, and others concerned with partial-lane pavement widening. Their cooperation and assistance were most helpful.

PARTIAL-LANE PAVEMENT WIDENING

SUMMARY

The importance of adequate width for traffic lanes is recognized by federal, state, and local highway officials. Safety, capacity, and maintenance costs are the factors that are associated with partial-lane pavement widening. Each of these factors benefit when narrow pavements are widened.

State roads usually are widened from 18 or 20 ft to 22 or 24 ft (5.5 or 6.1 to 6.7 or 7.3 m). Some county widening projects are the same as those for state roads, however, several counties are widening 12-ft pavements to 20 ft (3.6 to 6.1 m). Numerous counties have many miles of 10- or 12-ft (3.0 or 3.6 m) pavement that is in immediate need of widening. Nearly all the states responding to a 1973 survey indicated that some widening work was planned during the next five years.

Specific problems encountered on partial-lane pavement widening projects are:

- Narrow work areas.
- Acquisition of additional right-of-way.
- Variable subgrade.
- Reconditioning of existing pavement.
- Reflective cracking.
- Structure widening.
- Surface and subsurface drainage.
- Traffic during construction.
- Access for abutting owners.
- Funding for projects.

These problems have been addressed and practices have been developed to meet specific needs. Even the difficult question of funding has been met forcefully by one county that pays for widening projects from the general fund. Nearly all partial-lane widening projects include provisions for placing an overlay over both the old and new pavement. In a few cases the overlay may be placed during the following construction season.

Partial-lane pavement widening in most cases will require modification of the existing surface drainage. Pipes are extended, ditches shifted, and bridges widened. All the existing structures should be inspected and, when necessary, repaired or replaced before or during the widening construction.

Attention should be given to alignment improvements that can be made as a part of the pavement widening. This can be accomplished by shifting the widening, where possible, to the inside of curves. In some cases small angles can be replaced with a smooth curve.

Reflection cracks between the widening and the old pavement continue to be a problem. Practices that help to minimize these cracks include good subsurface drainage, compaction of the widening trench at or near optimum moisture content, providing good shoulder support for the widening, and the use of a substantial overlay to cover the joint.

The open trench for widening is an acceptable hazard on a single side during

daylight hours when adequate warning is provided. Most agencies prefer that the trench be filled at the end of each working day.

Access to abutting property is interrupted during pavement widening operations. Experience indicates that the agency and the contractor must assume responsibility for advance coordination with abutting residents and businesses to avoid undue inconvenience.

Recent development of trenching machines and compaction equipment has been useful for pavement widening. However, the cutting attachment on the motor grader blade is the most common excavation equipment and the trench roller is still widely used for the narrow widening projects.

CHAPTER ONE

INTRODUCTION

BACKGROUND

No feature of a highway has a greater influence on the safety and comfort of driving than the width and condition of surface. . . . However, on our early highways the need for reasonably wide traveled way was not so obvious. With continued upward trend in traffic volumes, vehicle speeds, and widths of trucks, main 2-lane highways have been increased from early widths of 16 to 18 feet to present widths of 22 to 26 feet. . . . The extra cost of 12-ft over 10-ft lanes is offset to a large extent by a reduction in cost of shoulder maintenance and a reduction in surface maintenance due to lessened wheel concentrations at the edge of pavements.*

Partial-lane pavement widening, the subject of this report, is the addition of less than a full lane of pavement on either edge of the existing pavement. In some cases, the total increase in pavement width may be greater than a lane 6 to 8 ft (1.8 to 2.4 m) on each side, but usually it is only 2 to 6 ft (0.6 to 1.8 m). Standard construction equipment is used for partial-lane pavement widening work; however, some modification may be required.

The three factors most often considered when planning partial-lane pavement widening improvements are safety, capacity, and maintenance costs. Highway officials and the general public accept the premise that wider lanes are safer. It is generally accepted that wider lanes also provide increased capacity. Maintaining the shoulders and edge of pavement on narrow county roads is costly. This cost can be reduced, or in some cases eliminated, by partial-lane pavement widening.

Both portland cement concrete (PCC) and bituminous mixtures have been extensively used to widen pavements. Some agencies have used one or the other as a matter of policy. Others match existing pavement or let the designer make the selection.

There is some indication that reflection cracking through the overlay may be more pronounced when PCC is used for widening, especially along the joint between the existing pavement and the widening. However, there are pavements that have been widened with concrete that have experienced only a limited amount of reflection cracking. Other factors that contribute to larger reflective cracks are the subgrade condition and the lateral support provided by the shoulder.

There is no lack of potential projects for pavement widening. State and county highway agencies have many miles of primary and secondary roads that are overdue for widening (Fig. 1). Current selection procedures consider the available funding and the facilities with the most pressing needs.

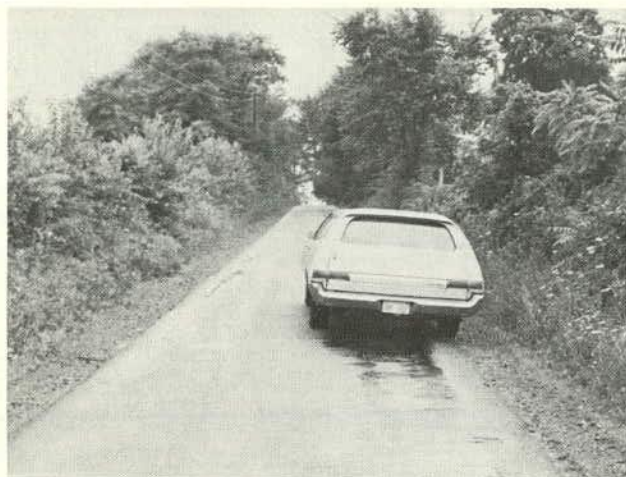
Safety

Wider pavements are considered more safe than narrow ones. However, sufficient accident information usually is not available to enable the highway official to present a strong case for pavement widening or positive proof that a particular accident would not have occurred if the pavement had been 2, 4, or 6 ft (0.6, 1.2, or 1.8 m) wider. Research has found, however, that the position of vehicles in both meeting and passing maneuvers is affected by pavement width. The relative positions of meeting trucks and an auto overtaking a truck are shown in Figure 2. In both cases the critical separation between vehicles and displacement from the edge of pavement is much less for the narrow pavement.

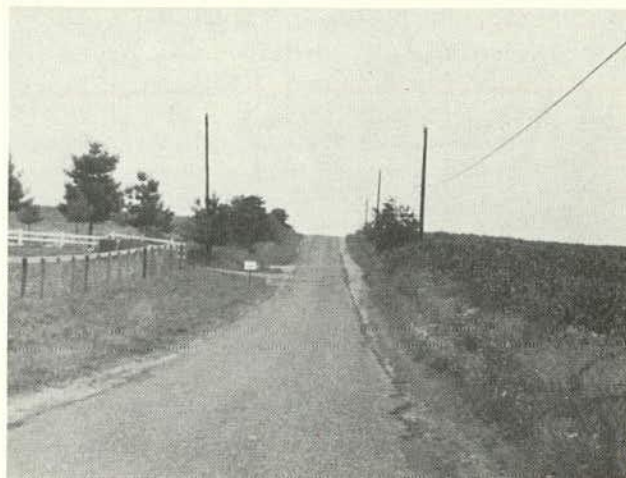
Capacity

Increases in the volume of traffic, particularly truck traffic, often are considered sufficient justification for widening pavements. The capacity of two-lane and multi-lane fa-

* "A Policy on Geometric Design of Rural Highways." AASHO (1965) 650 pp.



12-FOOT BITUMINOUS



12-FOOT BITUMINOUS



12-FOOT BITUMINOUS



10-FOOT P.C. CONCRETE

Figure 1. County roads in need of lane widening.

cilities can be increased by providing additional pavement width (Fig. 3). The addition of 3 ft (0.9 m) to each lane of a two-lane 18 ft (5.5 m) highway can increase capacity by more than 30 percent.

Maintenance Cost

Agencies do give some weight to the reduction of pavement edge and shoulder maintenance costs by widening pavements. Although this decision is based mostly on inference, there is reason to believe that the wider pavement is less costly to maintain and is safer because of less conflict with crews performing routine maintenance. Those counties having a considerable mileage of narrow paved roadways use much of their funds for shoulder maintenance. Experience has shown that these maintenance costs are reduced or almost eliminated when the pavement is widened.

CURRENT TRENDS

Most state highway agencies have some type of formal program for widening narrow pavements. A few do not have a formal program but do include partial-lane widening with other contract pavement work or perform the work with their maintenance forces. A 1973 survey of state practices found that 29 of the 42 respondents could estimate the mileage of existing pavement that they planned to widen during the next five years. Estimates ranged from 4 miles (6.4 km) to 2,000 miles (3200 km) for the five-year period (Fig. 4). It appears that much of this partial-lane widening will be done to increase the capacity and safety of two-lane rural and suburban roads. In most cases the pavements will be widened 2, 4, or 6 ft (0.6, 1.2, or 1.8 m) to 22- or 24-ft (6.7 or 7.3 m) widths. In a few cases two-lane pavements will be widened to 24 ft (7.3 m) and incorporated into divided four-lane systems.

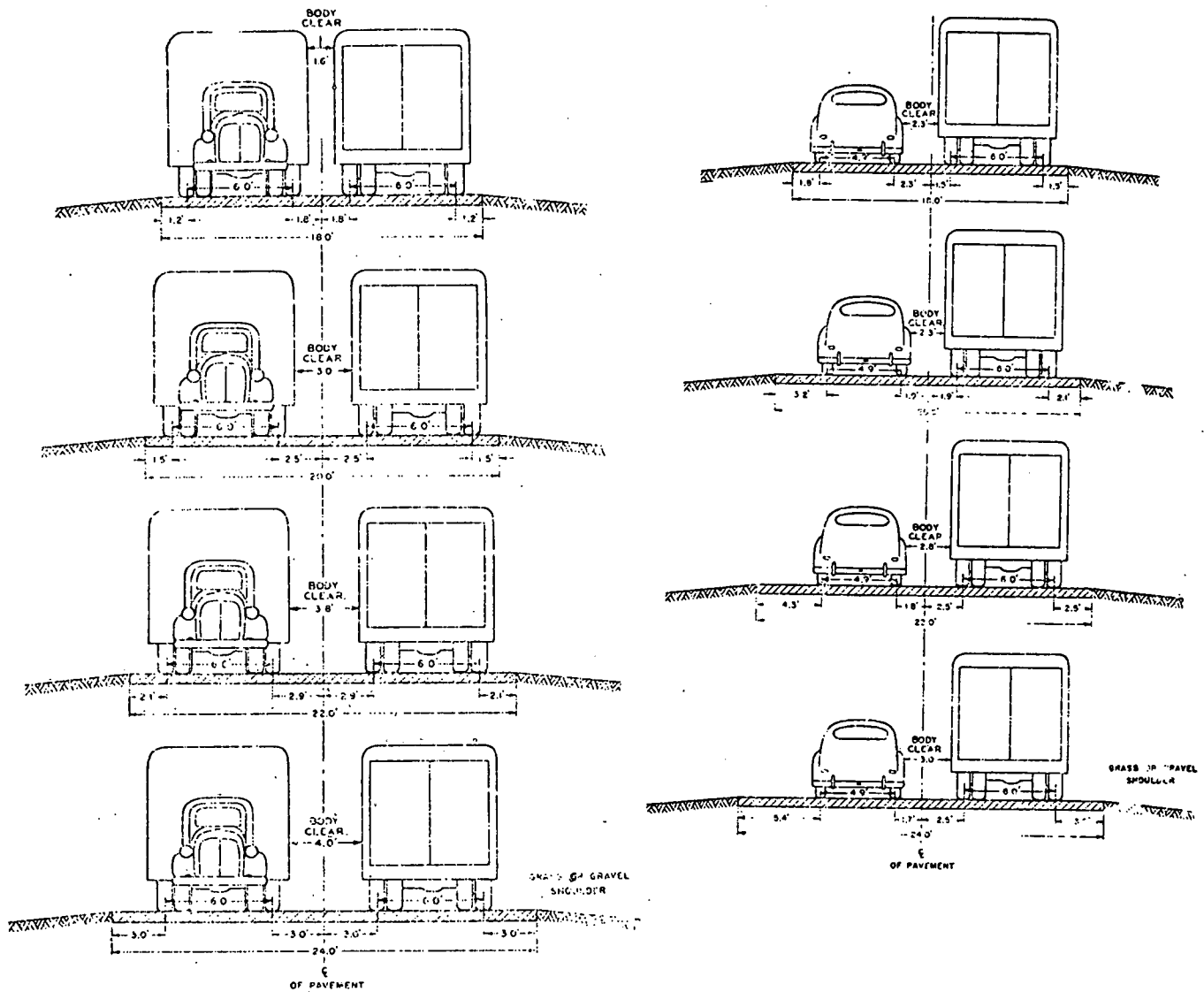


Figure 2. Effect of lane width on vehicle separation. (Source: Taragin, HRB Bull. 170)

LANE WIDTH (FT)	CAPACITY (% OF 12-FT LANE CAP.)	
	2-LANE HIGHWAYS	MULTILANE HIGHWAYS
12	100	100
11	88	97
10	81	91
9	76	81

Figure 3. Effect of lane width on capacity for uninterrupted flow conditions. (Source: Table 5.1, Highway Capacity Manual)

PROBLEM AREAS

Partial-lane pavement widening is not as simple as blading up aggregate against the existing pavement and covering it with some type of protective cover. Specific factors that continue to be problems are:

1. Narrow work areas.
2. Acquisition of additional right-of-way.
3. Varying subgrade support.
4. Reconditioning existing pavement.
5. Reflection cracking.
6. Structure widening.
7. Surface and subsurface drainage.
8. Traffic during construction.
9. Access for abutting owners.
10. Funding for projects.

Some of the aforementioned problems have been ad-

dressed by highway agencies and practices have been developed to meet specific needs. These practices may be used or modified by others to solve or partially solve their problems.

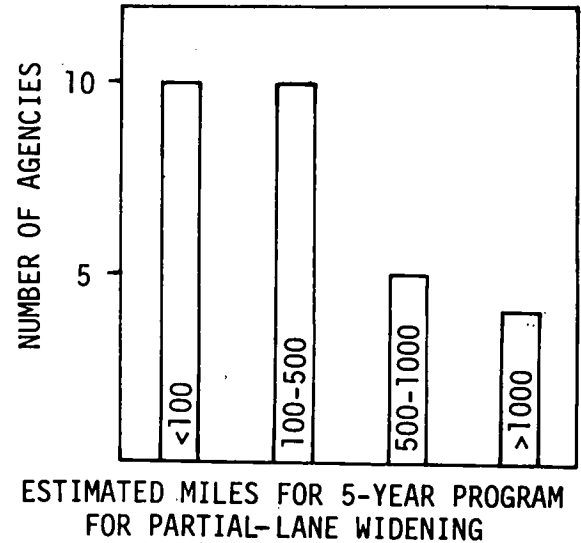


Figure 4. 1973 survey of states planning partial-lane widening.

CHAPTER TWO

PLANNING

It is common practice in many highway agencies to include partial-lane pavement widening in the planning process. Some consideration is given to upgrading of roadway and structures in long-range plans; however, it is more common to find pavement widening included in the short-range planning of five years or less. Careful study is given to the long-range traffic projections to determine if the widened facility will be adequate. Several agencies have widened existing pavements to meet present or short-term needs. Some have used widening techniques to provide additional traffic lanes. Most agencies upgrade the load-carrying capability of the facility as a part of the widening work.

LONG-RANGE PLANS

The long-range plan covers the agency's 5-, 10-, or even 20-year estimation of traffic demands and the methods of meeting the demands with existing routes and additions to the system. Upgrading of the existing routes often is a vital part of this effort.

It has been common practice to use stage construction when designing flexible pavements; i.e., base and seal coat now, road mix later, and eventually a high-type plant-mix surface. However, this approach has seldom provided any scheme for widening of pavement lanes and shoulders. Be-

cause right-of-way (ROW) is an important consideration in any widening project, many agencies now recognize the need for obtaining sufficient right-of-way initially to permit reasonable upgrading of the level of service at some future date.

Some routes do not warrant major widening projects. Poor alignment, both vertical and horizontal, limited right-of-way, and heavy conflict with existing traffic may dictate the selection of a new route. The decision to reconstruct or relocate rather than to widen usually is based on an in-depth study that considers all factors for each alternative. (See Appendix B.)

SHORT-RANGE PLANS

Much partial-lane pavement widening is performed as a part of short-range programs. In some cases, the widened facility meets existing needs or satisfies short-term estimates for increased traffic. One highway agency added 4 ft (1.2 m) to an existing pavement to upgrade the level of service so that the road could serve as a detour during the reconstruction of a parallel route. The cost was offset by construction savings and user convenience. Some widening projects are constructed by an agency's maintenance force; most of these are scheduled on a year-to-year basis as funds become available.

PROJECT SELECTION

States and counties have little difficulty in finding pavements that need to be widened. The problem is to select those that most need widening to the extent that available funding will permit. If the widening projects in one area are advertised for contract collectively, there is a better opportunity to get lower bids. However, the need for spreading work to all sections of a jurisdiction may be more important.

Some agencies are equipped to perform a limited amount of widening work with their own forces. Others could do this work only by reducing normal maintenance work. In the latter case, the widening is contracted.

ALTERNATIVES

The requirement for citizen participation in the highway development process has resulted in a more careful study of all reasonable alternatives. Economic and environmental issues must be presented for all construction projects. Some

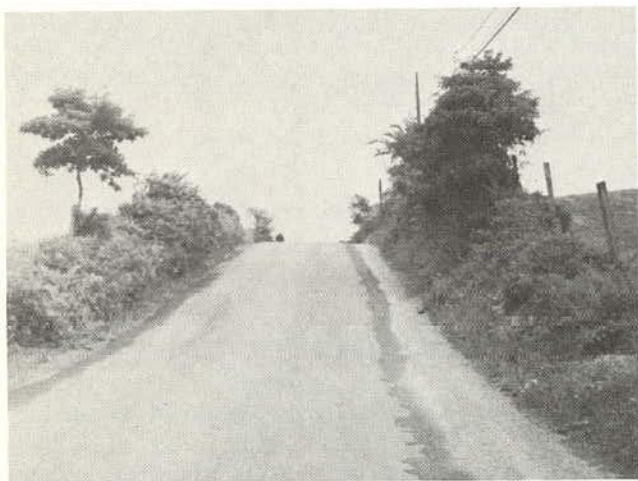


Figure 5. Narrow pavements requiring extensive edge and shoulder maintenance.

citizens strongly resist any work planned for an existing facility. Others oppose any attempt to relocate a facility or to provide an additional route.

Factors that may influence the decision-making process for pavement widening projects are:

- Present and future traffic.
- Project cost estimates.
- Disruption to abutting property.
- Right-of-way requirements.
- Construction noise, pollution, etc.
- Drainage requirements.
- Access to private and business property.
- Construction problems.
- Traffic problems.
- Traffic problems during construction.
- Community support (or lack thereof).

MAINTENANCE COSTS

One yardstick that is available to the planners when considering widening projects is the past, present, and anticipated cost of pavement and shoulder maintenance. One indicator of insufficient pavement width is high use of shoulders and resulting high maintenance costs for pavement edge and shoulders (Fig. 5). Although widening can provide some correction, the total pavement structure should be studied before reaching a final decision.

FUNDING CHOICES

The planner is aware of available sources of funding and the ability or inability of the agency to utilize these funds. In many cases, the cost of partial-lane pavement widening is paid entirely from state or local funds. Some believe that, in a few cases, desirable widening projects were not scheduled because the funding for construction on a new route or complete reconstruction along an old route was given higher priority. All too often widening projects are dependent upon "bottom-of-the-barrel" funding.

A few county highway officials have been successful in obtaining support from the general fund for an annual pavement widening program. Frederick County, Maryland, has had such a program for several years.

TRAFFIC

Unfortunately, many pavement widening projects, when completed, will hardly carry the existing traffic. The need for pavement widening projects on many rural and urban two-lane facilities exceeds by many times the resources available for this work. Discussions with county highway administrators indicate that many miles of their systems should be widened for today's traffic. However, the demands for paving unsurfaced roadways and the cost of surface maintenance deplete much, if not all, of the available funding.

The recommended AASHTO widths for specific traffic volumes are given in Figures 6 and 7. Many miles of state and county roadways fall short of these recommendations.

WIDTHS OF SHOULDERS FOR 2-LANE RURAL HIGHWAYS

Design volume		Usable shoulder width, feet	
Current ADT	DHV	Minimum	Desirable
50-250	—	4	6
250-400	—	4	8
400-750	100-200	6	10
—	200-400	8	10
—	400 and over	10	12

Figure 6. AASHTO shoulder width recommendations.

FIELD INSPECTION

Many, if not most, pavement widening projects are a part of a major rehabilitation effort that is intended to upgrade the load-carrying capacity of the facility. Only a few projects include partial-lane pavement widening without some type of overlay. In either case there is a need for a detailed examination of the existing roadway. The first examination should be made during the planning phase to help in the determination of the roadway section, preliminary cost estimates, details on structures that will be ad-

MINIMUM WIDTHS OF SURFACING FOR 2-LANE HIGHWAYS

Design speed, mph	Minimum widths of surfacing, in feet, for design volumes of:*				
	Current ADT 50-250	Current ADT 250-400	Current ADT 400-750	DHV 200-400	DHV 400 and over
			DHV 100-200		
30	20	20	20	22	24
40	20	20	22	22	24
50	20	20	22	24	24
60	20	22	22	24	24
65	20	22	24	24	24
70	20	22	24	24	24
75	24	24	24	24	24
80	24	24	24	24	24

* For design speeds of 30, 40 and 50 mph, surfacing widths that are two feet narrower may be used on minor roads with few trucks.

(1 mph = 1.609 km/hr)

Figure 7. AASHTO pavement width recommendations.

justed, and some indication of additional right-of-way requirements. A more detailed examination is required for the designer. This will be discussed later. If recent traffic count data are not available, some estimate of existing traffic should be obtained, including truck counts.

CHAPTER THREE

DESIGN

It is common practice with many highway agencies that each partial-lane pavement widening project be designed individually, using agency standards where possible. Others use standard widening plan sheets that are modified as required for each project. In either method, design attention is given to the specific requirements for each project (Appendix C).

EVALUATION OF EXISTING PAVEMENTS

All agencies attempt to evaluate the condition of existing pavement, base, and subgrade before designing the widening. Often this is a visual inspection tempered with experience and judgment. Surface patching, rutting, shoulder shoving, pumping, and surface cracking are good indicators that the existing pavement is barely meeting the needs of current traffic and that some improvement is required before increased or heavier traffic can be accommodated. Although this may be only a cursory study, it is often adequate when the observer is acquainted with local problems and has experience with the solutions that have proved successful to correct or eliminate them.

Many agencies supplement the visual inspection with deflection tests, soil surveys, open inspection holes, coring or

boring and past maintenance experience. A study of these indicators along with specific measurement provides the designer with the information required to prepare a satisfactory design.

The problems caused by swelling and heaving soils under widened sections is widely recognized. It appears that the effects of both frost heave and swelling are more pronounced, or at least more visible, on pavements that have been widened. Special subgrade treatments with lime and other additives have been used to minimize these adverse effects (Fig. 8), and the need for these treatments should be considered during the evaluation process.

Most state and county highway agencies place a minimum 2 in. of overlay material over the entire roadway after widening. This immediately follows the widening in most cases. However, seal coats have been used successfully to cover widening. The condition of the existing pavement and the amount and type of traffic are factors in the choice between seal coat versus overlay.

Questions that are answered during the pavement evaluation phase are:

- Is subgrade treatment required?
- How thick should the base course be?

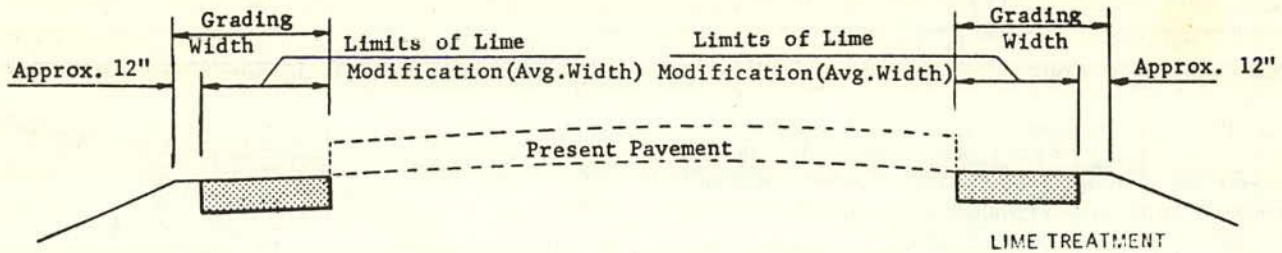


Figure 8. Treatment of widened section with lime (Oklahoma).

- Is there a need for underdrains?
- Should a leveling course be used on the existing pavement?
- Will a seal coat be adequate?
- How thick should the overlay be?

STRUCTURE EVALUATION

The widening of culverts and bridges is a major cost in any pavement widening project. Culverts are inspected during the field study to determine their condition and capacities. Unfortunately, there have been widening projects where no evaluation of culvert condition was made prior to design and construction. Some of the in-place cross drains that were extended are now in need of replacement—at considerable cost. The alignment of the drainage structure is usually checked to insure that any necessary extension will not cause property damage.

The condition of bridge decks is inspected carefully to detect any indication of corrosion. If a major repair effort is required for the bridge deck, this work may be incorporated with the widening of the structure. However, it is more common practice to schedule structure widening as a separate contract. Many county roads have narrow

bridges that cannot be replaced because of the non-availability of funds for this purpose. A few have been able to use large pipes to replace some structures (Fig. 9).

GEOMETRICS

Alignment improvements can be undertaken as a part of partial-lane pavement widening. Sharp breaks in vertical alignment may be improved; horizontal curves can be flattened by placing all the widening on the inside (Fig. 10), where possible. Some existing horizontal curves do not have extra width as recommended by AASHTO (Fig. 11). This extra width can be placed as part of the widening project or by maintenance forces.

Most widening projects add 2 to 6 ft (0.6 to 1.8 m) of pavement to two-lane roads. A few projects have increased 36-ft (11 m) pavements to 44 ft (13.4 m). In other cases, 24-ft (7.3 m) pavements have been widened to 36 ft by placing 6 ft on each side. If the widening is balanced, there are no major problems except where a two-lane roadway is to become part of a divided four-lane system. In these cases, the removal of the crown may require a special wedge and additional shoulder construction (Fig. 12). If an unbalanced or unequal widening scheme is used, the



(a)



(b)

Figure 9. Narrow structures similar to (a) have been replaced with multiple lines of pipe (b) as part of a widening project.

pavement crown must be shifted to the center of the reconstruction section.

In some cases large structures are not widened. If widening of the structures is planned, the pavement widening may be carried up to the structure. If not, the widening section can be tapered as shown in Figure 13. This taper also can be used at the end of projects to tie in widened sections with the existing pavement. If the widening is ended abruptly in either case the transition can be effected by a gradual shift of an edge stripe over the taper distance.

Limited shoulder space for pavement widening may require modification of the existing ditch section. One common practice is to completely fill the ditch and use a raised curb to control the pavement runoff. In many cases, if the ditch section is replaced with a curbed section, the need for benching or widening the cut is eliminated. This technique often can provide enough extra width to eliminate a need for widening on the opposite side. This is particularly helpful when the opposite side is in a fill section and might require extensive benching for placement of a narrow fill section.

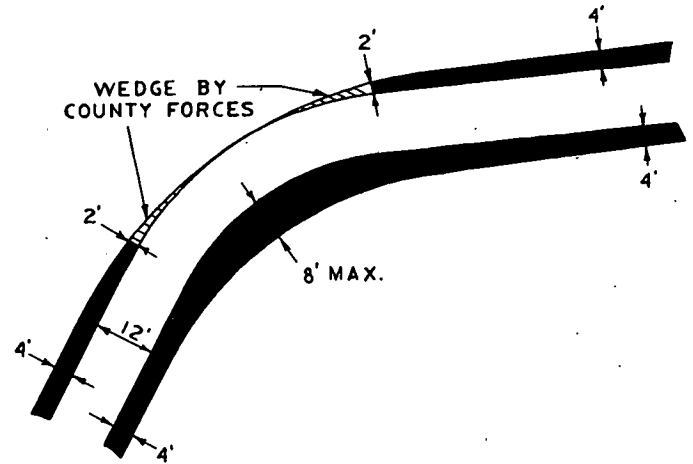


Figure 10. Plan view of typical widening operation (Frederick County Roads Board).

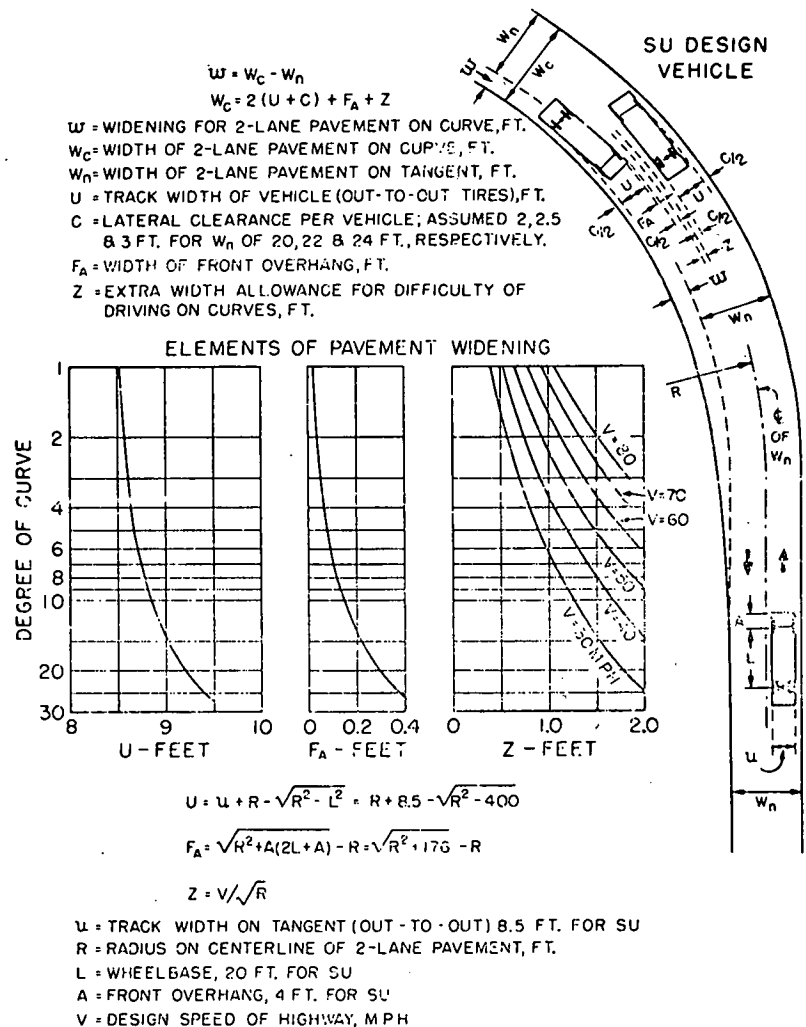


Figure 11. Pavement widening on curves (AASHTO).

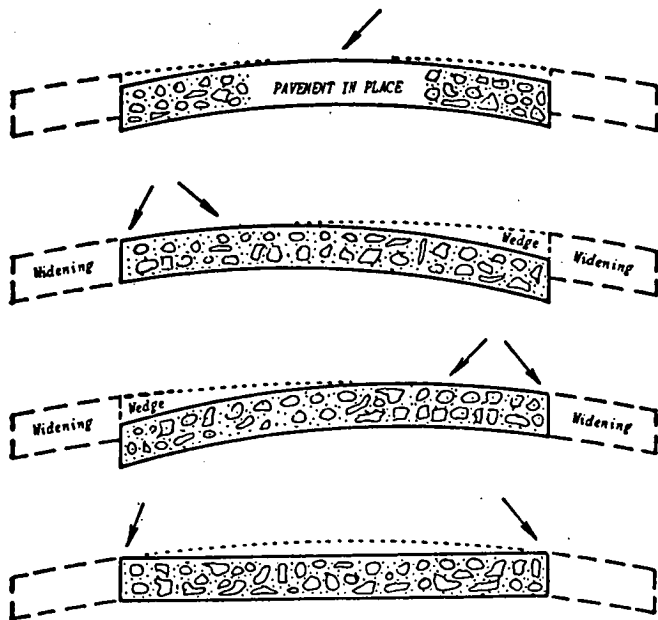


Figure 12. Adjustment of PC widened pavement.

JOINTS

The Achilles heel of partial-lane pavement widening is the longitudinal joint between the existing pavement and the widening. If any type of fault develops in the widened section or in the old pavement, it is most visible at the joint (Fig. 14). Settlement, heave, swell, and failure of lateral support are the principal causes of uneven or wide joints. Lateral movement and faulting of the existing pavement

also will produce joint problems that may adversely affect the widening operation.

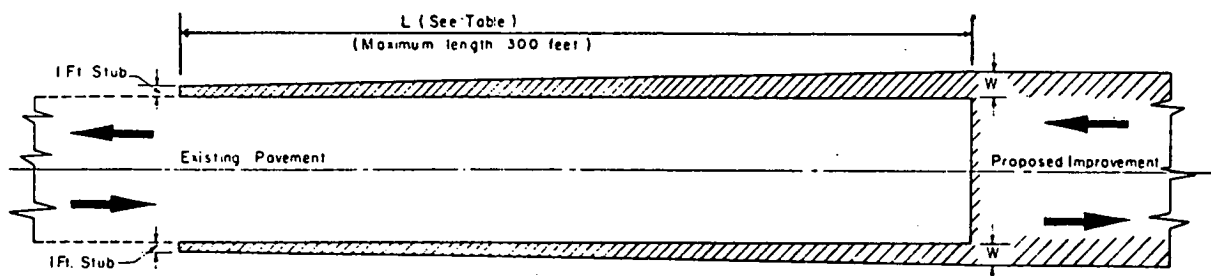
Only a limited amount of work is specified for the joint area by most agencies. A few do not have any specific requirements other than a straight and vertical surface. Others specify that the existing pavement be painted, primed, or tacked with bituminous material. Some have used tie bars when PCC pavements were widened with PCC; however, this is a slow and costly process. A few have specified a special stepped joint as shown in Figure 15. If there are no horizontal planes between courses of material, these joints also are expensive and time consuming. Although a neat line can be sawed in the bituminous surface, the base material may crumble under normal construction activity.

It was mentioned by contractors that it was much easier to obtain a neat joint against PCC than against bituminous or mineral aggregate base. In some cases, the only reason for placement of an overlay on a widened pavement is to cover the joint.

DRAINAGE

Surface

Most agencies attempt to upgrade or correct deficient drainage as a part of widening contracts. In some cases, pipe sizes are increased or additional cross drains are installed. The need for additional side drains is reviewed and when funding permits, new installations are provided. Paved ditches, sodding, curbing, and other devices to protect the ditches and slopes are also installed as a part of widening contracts. Short runs of storm sewers may be used to avoid extensive grading work or purchase of additional right-of-way.



GENERAL NOTES

The material used for the transition shall be the same type as was used to construct the widening or pavement. The thickness shall be the same as that of the widening or pavement being constructed.

This work will be paid for at the contract unit price included in the contract for the type of widening or pavement being constructed.

TRANSITION LENGTHS FOR VARIOUS WIDTHS	
W feet	L feet
2	150
3	200
4	250
6	300

STATE OF ILLINOIS DEPARTMENT OF PUBLIC WORKS & BUILDINGS DIVISION OF HIGHWAYS		ISSUED 7-1-69 REVISIONS	
PASSED	3-27-70	KHW	3-23-69
Engineer of Road Plans and Contracts		G.R.	8-1-69
APPROVED	4-27-70	W.F.	3-18-70
Engineer of Design			

Figure 13. Transition lengths for widened sections.



Figure 14. Rutting or settlement and cracking along widening joint caused by poor compaction or inadequate sub-grade support.

Subsurface

Many agencies include provisions for the removal of subsurface water from under the existing pavement. Because the widened section often is deeper than the existing section, special attention is given to this problem area. One practice is to use an open-graded, free-draining material in the bottom of the trench. Supplementary drains are used to carry the water through the shoulder at designated intervals and at low points on vertical curves (Fig. 16). Another practice is to use a collection system that includes perforated pipe to collect the water and transport it to the ditch or catch basins (Figs. 17 and 18). Free-draining aggregate is also placed in the bottom of existing ditch sections to provide drainage when the ditch is to be filled.

Cross Drains

Most designers specify that existing pipe culverts be extended with the same type of material. This eliminates joint matching and dissimilar materials problems. Special end sections may be used to avoid purchase of additional right-of-way. The capacity of each line of cross drain should be checked against the runoff that is estimated for the site. Maintenance foremen or adjacent residents often can provide information on the adequacy of drains. One item of work that frequently is not considered is the re-

quirement for cleaning the in-place drainage. This may be done as a part of the contract or by the maintenance force.

One problem encountered in the design of culvert extensions is the provision for minimum cover over the upstream end of pipes laid on a steep grade. If the existing grade is continued, the extended pipe would actually protrude through the shoulder (Fig. 19). If the pipe grade is broken, the joint with the existing pipe is not satisfactory. Each installation is usually considered separately and special work identified to insure a satisfactory installation. This may involve removal of a few feet of the existing pipe and the placement of a special poured or fitted joint.

MATERIALS

There is an apparent trend toward using bituminous material for the total depth on partial-lane widening projects. An open-graded mix can be placed in the bottom of the trench followed by a binder course and surface. The thickness of each course will vary. If an overlay is to cover

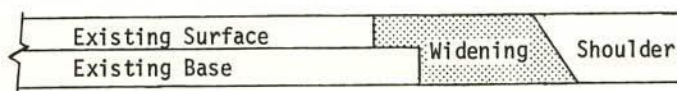
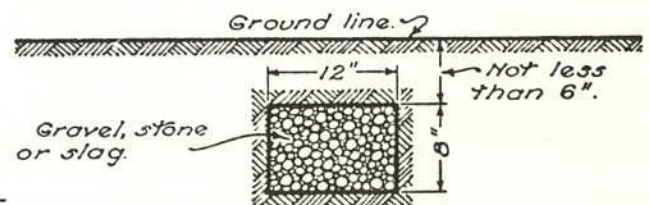


Figure 15. Step construction to minimize adverse joint effects.



Aggregate drains to be placed where and as directed by the Engineer.

Figure 16. Aggregate drains.

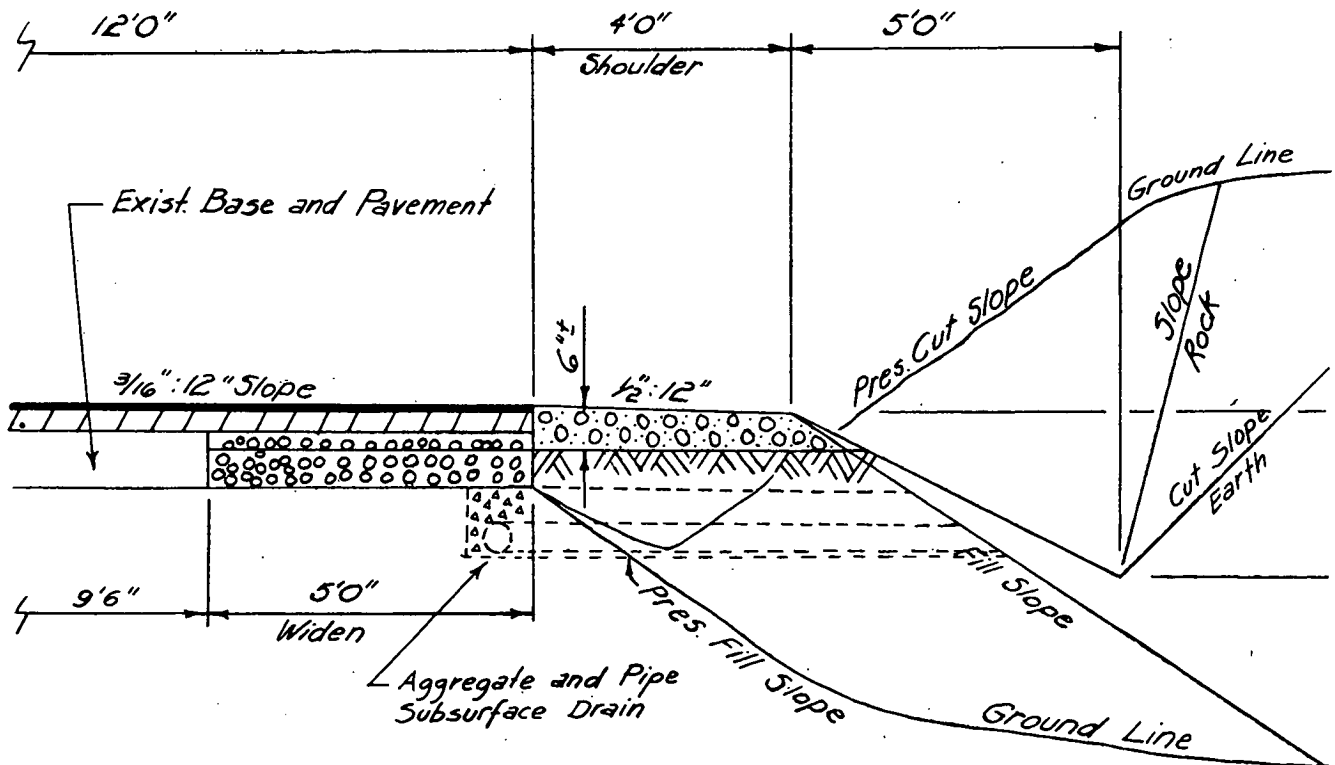
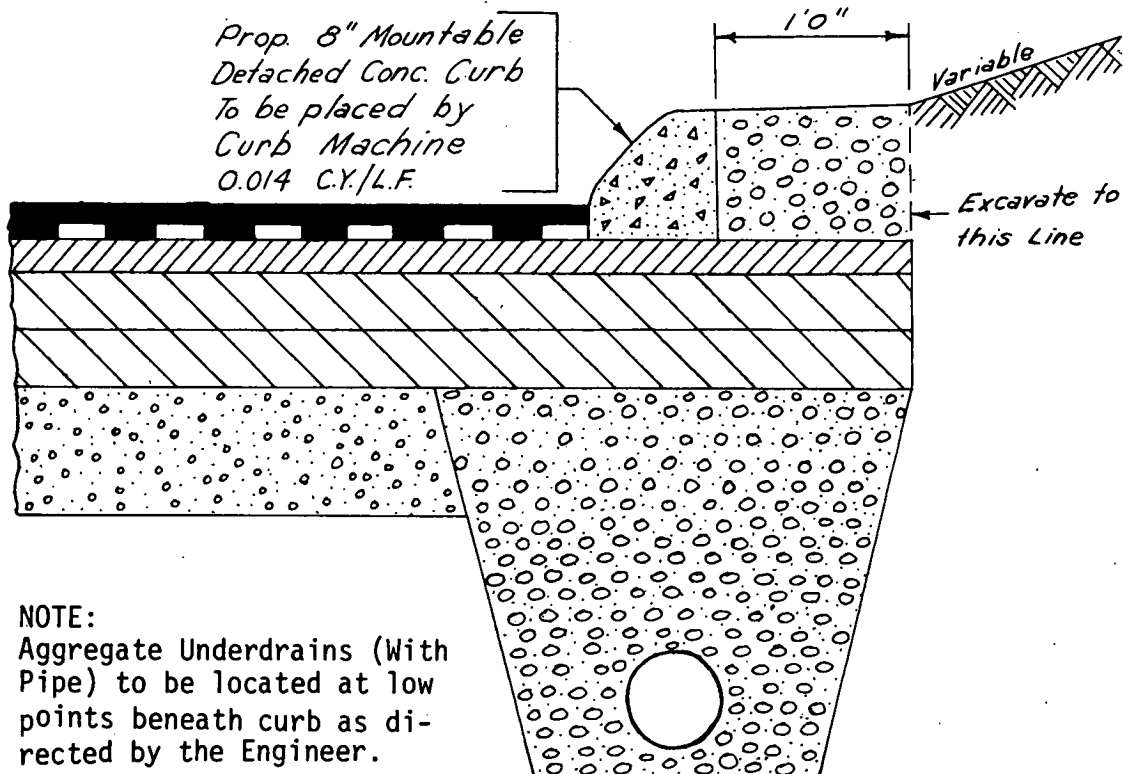


Figure 17. Subsurface drainage.



NOTE:
Aggregate Underdrains (With Pipe) to be located at low points beneath curb as directed by the Engineer.

Figure 18. Longitudinal underdrain.

the widening, the binder material may be used up to the top of the existing pavement surface.

Some agencies still prefer to widen PCC pavement with PCC when there will not be an overlay. Research in Illinois with lean mix concrete base widening indicated that a cement content as low as 1.07 barrels per cubic yard (239 kg cement/m³) of concrete could be used for some conditions when covered with a dense-graded bituminous resurfacing.

Many widening designs carry the widening section through the complete width of the shoulder. This eliminates the problems associated with placing a narrow section of aggregate, dirt, or some other material against the widened section. Many believe the cost of placing selected soil material on the shoulder is greater than placing aggregate.

BRIDGES AND STRUCTURES

In some instances bridges and large culverts are widened in advance of pavement widening. In other instances the pavement widening is completed in advance of structure widening. The two factors affecting the timing are safety and availability of funds. Most agencies have a spot-safety improvement program that has included numerous widening projects for structures. In most cases, structures have been widened equally on both sides. Occasionally, the complete superstructure of a bridge is replaced with a wider roadway. Another common practice is to replace narrow structures with one or more large pipes. The condition of many bridge decks damaged from deicing chemicals may create a demand for additional contracts that widen and replace the deck.

Several agencies have standard tapers for transitioning the pavement width at structures. This was discussed under "Geometrics."

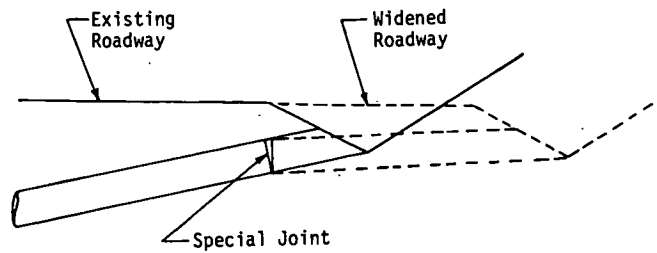


Figure 19. Extended drainage pipe in widened section.

UTILITIES

The placement of underground, surface, and aerial utility devices can materially affect the planning, design, and construction of widening projects. On many routes that are in need of widening, there are poles, conduits, and cables that must be moved or adjusted. Each state has laws, regulations, or policies that help determine if the agency is liable for these costs. In some cases the concerned utility is not financially able to move their facility.

If the adjustment of utilities is to be carried out during the widening contract, the plans will note the areas of conflict and notify both the utility and the contractor that they will be required to attend a preconstruction conference to discuss their plans.

It is common practice for highway agencies to discuss their short- and long-range plans for minor and major highway widening and reconstruction projects with utility companies. In several instances this has enabled the utility to schedule major renovative efforts along with the highway work. A few agencies have scheduled specific work items to accommodate the relocation or adjustment of water or gas lines, buried cables, and critical poles or transmission towers.

CHAPTER FOUR

CONSTRUCTION

SAFETY AND TRAFFIC CONTROL

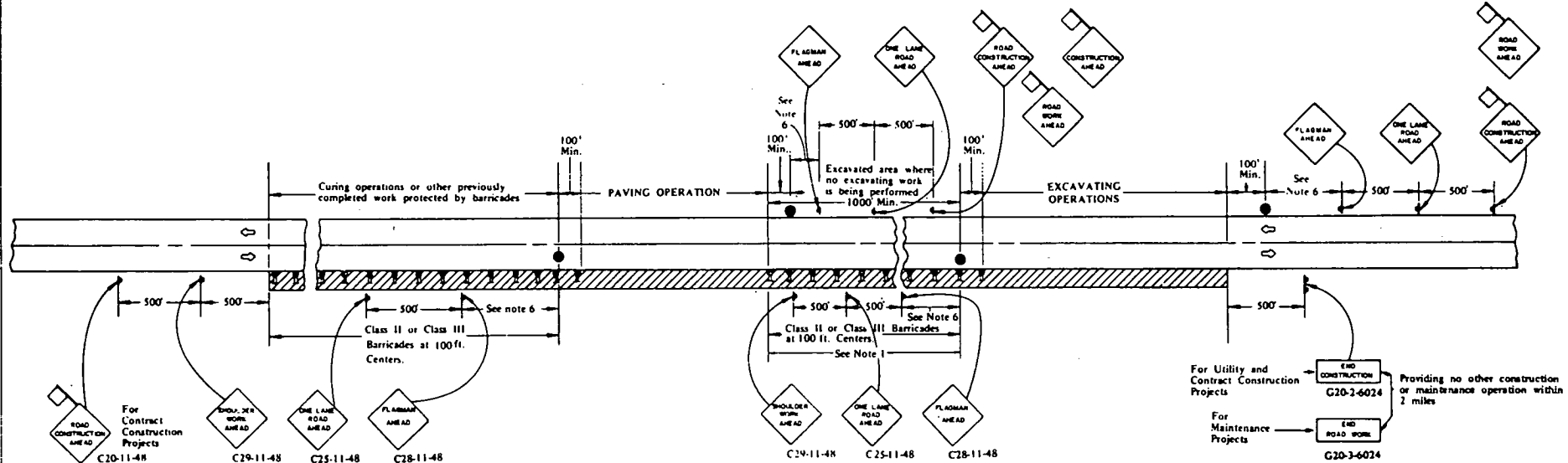
There can be little doubt that construction of partial-lane pavement widening can be hazardous to both traffic and the construction workers. It is sometimes possible to maintain two-way traffic; however, it is more common practice to use flagmen to direct all traffic through the work site in a single lane. Figure 20 shows one standard plan that was developed for construction forces as a guide to handling traffic on widening projects. Additional information on advance

warning signing is given in Chapter 6 of the Manual on Uniform Traffic Control Devices (MUTCD).

The excavated trench is a traffic hazard during daylight and even more so at night. It is common practice to require the trench to be filled up to the level of the existing pavement or to within some specific depth. The material is bladed against the edge of the pavement to ease the drop-off if vehicles should leave the pavement. Some agencies permit the trench to remain open but specify closely placed warning lights, barricades, and reflectors (see MUTCD).

STANDARD DESIGN

TYPICAL APPLICATION OF TRAFFIC CONTROL DEVICES FOR HIGHWAY CONSTRUCTION AND MAINTENANCE



GENERAL NOTES

- Where the distance between paving and excavating operations is less than 2,000 ft., the entire operation may be considered as one work area for signing purposes. When the distance between operations exceeds 2,000 ft., additional warning signs shall be placed as shown. Under restricted sight distance conditions, such additional devices may also be required for distances less than 2,000 ft. at the discretion of the District Engineer.
- Two flagmen shall be required for each separate construction operation 1,000 ft. or less in length.
- The flagmen shall be in sight of each other or in direct communication at all times.
- Construction operations shall be confined to one traffic lane leaving the opposite lane open to traffic. At least 500 feet of both traffic lanes shall be available for traffic movement at intervals not greater than 1,000 ft.
- No paving or excavating operations shall be performed at night unless authorized by the District Engineer.
- When these operations are suspended, all vehicles and equipment, including traffic control and protective devices, shall be removed from the pavement and the excavated area shall be protected by Class II or Class III Barricades at 100 foot centers. ROAD CONSTRUCTION AHEAD or ROAD WORK AHEAD and SHOULDER WORK AHEAD signs shall be installed as shown to protect the curing operations. ROAD CONSTRUCTION AHEAD and ROAD CONSTRUCTION 500 FT or ROAD WORK AHEAD and ROAD WORK 500 FT signs shall be installed for traffic in the opposite direction.
- Minimum distance is 200 ft. Maximum distance to be determined by the District Engineer but in no case to exceed the length of 1/2 day's operation.
- Steady burning lights will not be required on Class II or Class III Barricades for day operations.
- All signs shall be post mounted if the working time exceeds four days.
- High intensity flashing lights shall be used on each approach in advance of the work area and installed above the first two signs in each series.
- When a side road intersects the highway on which work is being performed, additional traffic control devices shall be erected and flagmen provided as directed by the District Engineer.
- Longitudinal dimensions may be adjusted slightly to fit field conditions. The lateral placement of the flagmen may be varied from that shown.
- All warning signs shall have minimum dimensions of 48 in. by 48 in. and have black legend and border on an orange reflectorized background. All signs other than warning signs shall have as a minimum the dimensions shown and shall have a black legend and border on a white reflectorized background.
- All vehicles, equipment, men (except flagmen) and their activities are restricted at all times to one side of the pavement unless otherwise authorized by the District Engineer.
- Form BT 725 is required.

CASE XI

TWO-LANE, TWO WAY TRAFFIC, RURAL WIDENING OF PAVEMENT DAY OR NIGHT OPERATIONS

Where, at any time, any vehicle, equipment, men or their activities will encroach on the pavement during pavement widening operations.

STANDARD 2311-3

STATE OF ILLINOIS DEPARTMENT OF PUBLIC WORKS & BUILDINGS DIVISION OF HIGHWAYS	
APPROVED: <i>[Signature]</i>	REVISED BY DATE DAB 12-6-66 DAB 4-22-70 DAB 7-7-77

Figure 20. Two-lane, two-way traffic, rural widening of pavement day or night operations.

ACCESS TO ABUTTING PROPERTY

There have been many widening projects where the need for ingress and egress by abutting residents and businesses was not given adequate attention. If unnecessary access requirements are placed on the contractor, the project cost will increase. However, a lax attitude by the agency or the contractor will lead to numerous complaints and much ill will.

Access to businesses usually receives special consideration by the agency and by the contractor. In most cases the contractor will place material in the trench directly behind the trenching operation, or temporarily place cross ties, timbers, or other devices to permit the business to continue operation. In some instances, the business may be served by two access points, permitting the contractor to work on one while the other is kept open. Contact with abutting property owners should be made prior to or during the preparation of the contract plans so that specific access problems can be identified. The availability of this information permits bidders to include the costs in their bids.

CONSTRUCTION CONTROL

There is much concern about the control of work on widening projects. This concern is shared by the abutting residents and businesses, the highway agency, and the contractor. The principal problem is the trench cut for the widening. The work period in the vicinity of each business or residence is longer than for seal coats or overlay construction and may require the removal and replacement of mailboxes, driveways, and walks. In some instances the fronts of lawns and parking areas may require regrading. The existing provisions for drainage may require modification to fit the widened section. Because some of this work may be performed on private property under a construction easement or the special permission of the owner, both the agency and the contractor must be certain that the owner is well informed.

Discussions with highway agencies and contractors performing widening work indicate that the agency should be directly involved with all work; however, the contractor should be free to exercise his initiative in establishing production rates and in getting the work completed. If the



a. Trench cut on one side



b. First course placed and compacted



c. Trenching and placing material on other side



d. Widening complete - ready for overlay (or seal coat)

Figure 21. Work sequence followed on a state widening project.

agency desires that the trench be closed at the end of the working day, the contract should include this provision.

The construction sequence followed in one state widening project is shown in Figure 21.

TRAFFIC CONTROL

On most widening projects the contractor is completely responsible for the control of traffic through the work site. The project plans or other contract documents will spell out specific requirements and refer either to the agency standards or the MUTCD.

Flagmen are used to hold and direct traffic to the lane that is not occupied by construction equipment. Additional flagmen may be required at cross roads or to direct traffic where construction vehicles or equipment is working, moving, or turning. Several agencies have inspectors from the headquarters or regional office to check the advance signing and handling of traffic. Unsatisfactory practices or conditions are brought to the attention of the project inspectors and the contractor.

TRENCHING

Cutting the trench and removing the excavated material is the most difficult part of the widening project. One widely used technique for cutting the trench is to modify the

common motor grader blade by adding a custom-designed cutter and a special mold board to deflect the material either to the ditch or pavement side (Figs. 22, 23). It is helpful to use the grader scarifier teeth to rip the material before attempting removal with the adapted blade. Front-end loaders also have been adapted to cut trenches and underdrains. Wheel-type trenching machines that can load the excavated material directly into haul units are considered ideal for this type of work but are not widely used at this time. The removal of excavated material from the ditch usually requires rubber-tired loaders. Elevating loaders are used to pick up material from the pavement and load it into trucks.

Practices vary on the treatment of the bottom of the trench. Some agencies specify a well-compacted and rectangular-shaped bottom. A few do not specify any compaction; however, most agencies require that the bottom of the trench be compacted at or near optimum moisture content. If the foundation soil is expansive clays, some would recommend that it be compacted slightly wet to avoid later swelling.

PLACEMENT AND COMPACTION

There are several types of equipment that are used for placing widening materials. Most contractors use a widen-



Figure 22. Motor grader with modified blade cutting widening trench.

ing or shoulder machine for cold mix bituminous and mineral aggregate materials (Fig. 24). Specially adapted bituminous pavers are also used. It would appear that the use of vibratory compaction equipment permits the placement of deeper lifts of materials. Because of the time loss in transporting or walking the placing machine back to the beginning of the section, the thicker lifts represent a considerable savings in placing costs and reduce interference with traffic.

The compaction equipment must be capable of traveling in the trench. Some have attempted to overfill the trench and then use a conventional roller to compact the entire layer until it was flush with the existing pavement. This method is not considered satisfactory. Often, there is insufficient material placed to obtain adequate density during rolling, and further compaction occurs under traffic.

The suggestion was offered by one contractor that roughly two-thirds of the total depth be placed and compacted in a single lift and the remaining one-third in a second lift. This was concurred in by other contractors and some highway agency personnel.

NARROW CUT AND EMBANKMENT CONSTRUCTION

The requirement for only a few additional feet of width to widen a pavement can result in unusually narrow cuts or fills. However, cuts and embankments can be constructed at a reasonable cost with standard equipment.

Small crawler type dozers that are capable of making narrow cuts are available from several manufacturers. The material is bladed over the edge of the cut and picked up



Figure 23. Widening trench on county widening project. The existing 12 ft (3.6 m) is being widened on each side to provide a 20-ft (6 m) roadway.

in the ditch. If the cut is 10 ft or more, scraper units can be used to load directly from the bench. Gradall equipment has also been used to remove material and to shape widening cuts.

Material can be back dumped over the embankment for spreading and compacting to widen embankments. Single drum sheepfoot or vibratory rollers are used for compaction. Most agencies require that the new material be well keyed into the existing embankment.

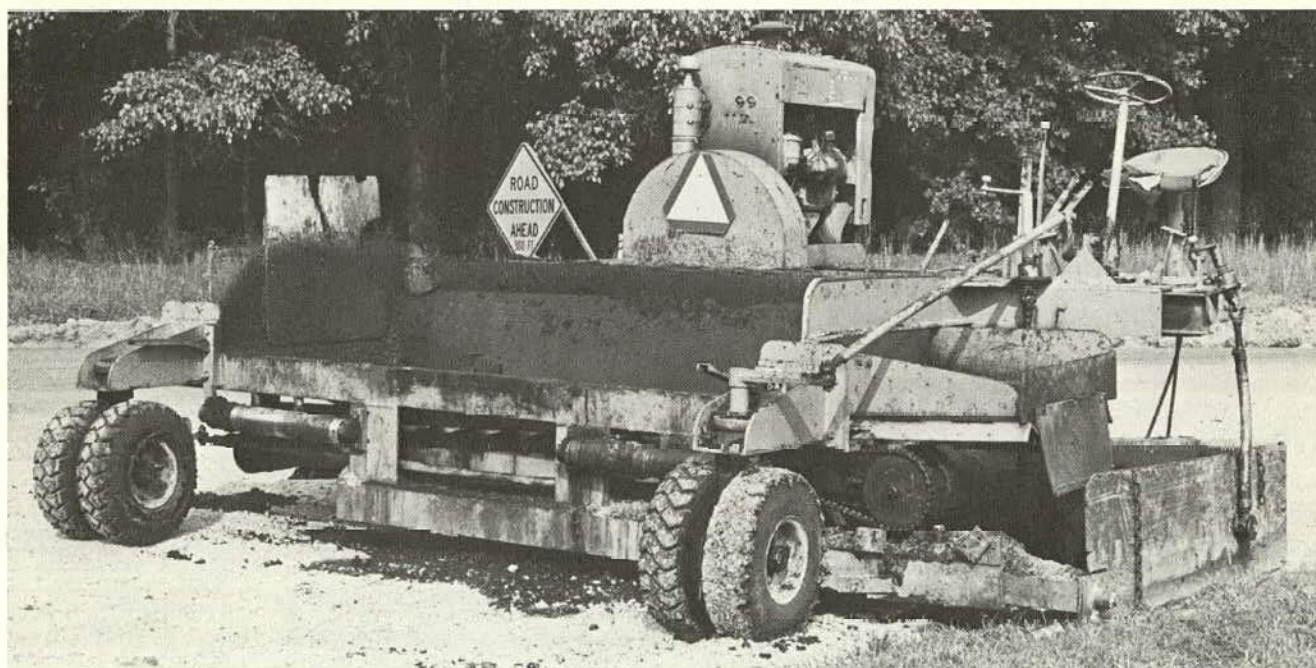


Figure 24. Shoulder machine used for placing pavement widening.

DISPOSAL OF MATERIALS

Much of the material removed from the trench can be used for shoulder work or to flush or widen embankments. It may also be used on site for grading berms and the like. If material is wasted off the project, the agency environmental requirements should be met.

PUBLIC RELATIONS

The public is more likely to accept the minor inconvenience of partial-lane widening if they are advised or warned in advance. Because of the interference with traffic, mail service, commercial delivery and other public service, advance notice via signs, TV, radio, newspaper or handouts should be given. If unusual problems are anticipated, the local or state police may be requested to provide assistance.

CHAPTER FIVE

CONCLUSIONS AND RECOMMENDATIONS

CONCLUSIONS

Existing pavements, even narrow ones, represent a major investment in highway funds and have considerable value. Only a few of these facilities can be completely abandoned, even where replacement facilities are constructed. The widening and upgrading of many of these roads is a good practice that improves safety and reduces maintenance costs (Fig. 25).

There is every reason to anticipate that many state, county, and city highway agencies will continue to plan and construct partial-lane pavement widening. In most cases the widening effort will be limited to adding 2 to 6 ft (0.6 to 1.8 m) to existing two-lane pavements.

Although many of these projects can be completed within the existing right-of-way, an increasing number of widening projects will require additional right-of-way on one or both sides. Many widened facilities can be upgraded to a higher level of service and may provide increased capacity that will eliminate or defer the need for a replacement facility.

Some two-lane roadways can be widened for climbing lanes by placing 4 to 6 ft (1.2 to 1.8 m) of pavement on each side. Space from the median and shoulder section can be used to widen four-lane facilities to six lanes.

The effects of frost or swelling action often is more noticeable on widened pavements than on existing pavements. If the new and old section foundations are not identical, the joint may be uneven during part of each year and cause water to pond on the pavement surface during rainstorms.

Any necessary improvements to both grade and alignment should be considered before roadways are widened. If this is not done, the widening work could prevent further improvements to the present grade and alignment for many years.

Factors that affect partial-lane widening cost are: size of

the project, trench width, traffic, drainage requirements, specialty work included in the contract, and availability of contractors with interest in the work.

RECOMMENDATIONS

Many of the problems associated with partial-lane widening can be minimized by careful preliminary investigation and improvements in design and construction. A thorough study of the existing pavement should be completed to provide some indication of the problems that can be anticipated in the widened section. Special designs for problem sections may be required.

Lateral support is essential for the edge of any pavement and particularly for widened sections. Shoulder support often has been inadequate for widened sections. Whenever at all practical, the minimum shoulder width that should be considered is 6 ft (1.8 m) on each side of 20 to 24 ft (6.1 to 7.3 m) pavements. It is recognized, however, that for many rural roads this recommendation is not practical and that the widened section can only make use of the available right-of-way.

Short sections in cuts can be economically widened without extra excavation if the open ditch is modified to use storm drains or in some cases filled with an open-graded material or filters. Perforated pipe may be specified to transport collected water to storm drains or open ditches.

Existing culverts and pipes should be examined and, if necessary, repaired or replaced before extending. There may be problems of compatibility of materials if metal pipe culverts are extended with dissimilar metals.

Widened sections perform better if good drainage is provided under the section and through the shoulder. A drainage blanket, French drains, or a collector system of perforated pipes may be used. Special attention should be given to low points on vertical curves and also to level grades.

Widening should be a minimum of 2 ft (0.6 m). If a



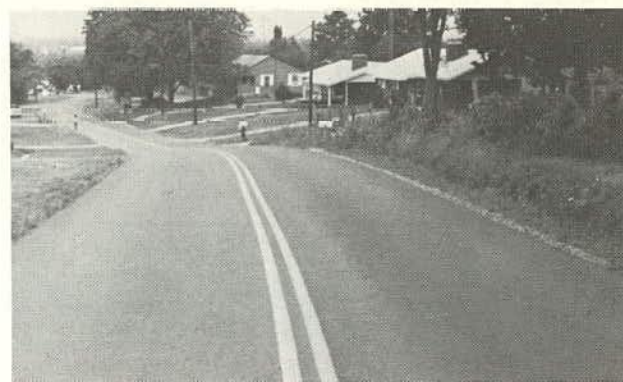
a. 1936 PCC pavement widened with bituminous material in 1958. Overlay placed in 1971.



b. 1940 PCC pavement widened with bituminous material in 1961.



c. County road widening plus seal coat.



d. County road widening plus overlay.



e. Brick state route widened plus overlay.



f. Bituminous widening of narrow PCC pavement on curve.

Figure 25. Examples of successful widening.

pavement is to be widened only 2 ft, the total width should be placed on one side. The cost of widening is related to the width of the trench and the number of operations. If additional right-of-way is required, the designer should compare total costs for widening on a single side against the costs for widening on both sides.

If thicker lifts of materials can be satisfactorily compacted, the number of operations and interference with traffic will be reduced.

Specific consideration should be given to minimizing heaving or swelling of subgrade soils.

The contracting agency should be responsible for early

coordination with abutting owners. Special requirements for access should be identified on the plans and in the contract. The presence of an open trench adjacent to the pavement reduces capacity and is a hazard, especially during adverse weather and darkness. Special warning signs and lighting should be specified if the trench is left open overnight; however, in most cases the widening trench can be completed and refilled with paving material at the end of the work day. Some reasonable amount of trench may be left open to facilitate starting the next day's work. In no case, however, should trench on both sides be left open. Pavement widening should be completed on one side before starting work on the other side.

Some maintenance units are adept in widening work, particularly short sections. However, these units may not be equipped or have sufficient personnel to undertake larger projects. Each project should be reviewed to determine which can perform the work most economically—maintenance units or contract forces.

The existing pavement on each widening project should be evaluated. Although overlays are recommended for

widened pavement, in some cases a seal coat may be satisfactory. In a few cases neither overlay nor seal coat may be required.

RESEARCH

There is little specific ongoing research that is directed to pavement widening. The principal problems are right-of-way, traffic, the restrictions placed on the contractor; and the equipment for cutting the trench, placing material, and compaction. Most of these problems can be handled by using existing knowledge and practice. No specific recommendation for formal research is offered.

There is available equipment that will cut the trench and load the excavated material in a single pass. It is doubtful that special equipment will be developed just for widening work; however, there is much standard equipment available that may be adapted to this work.

Individual agencies should review completed widening projects that have been in service for a number of years and hopefully develop widening techniques and designs that would not have unsightly joints or uneven settlement.

APPENDIX A

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APPENDIX B

DEVELOPMENT SEQUENCE FOR WIDENING PROJECTS

Feasibility Review

- Condition Evaluation
 - Pavement
 - Subgrade
 - Drainage
- Geometry
 - Grade
 - Alignment
- Capacity
 - Current
 - Potential
- Demand
 - Current
 - 10-, 20-year projections

Design

- Typical Cross Section
 - In cut
 - In fill
 - Balanced or unbalanced widening
 - Depth of widening
- Drainage
 - Alteration
 - Addition
- Right-of-Way
 - Additional ROW
 - Easements

Field PS&E

- Access Consideration
 - Private owners
 - Business
 - Public property
- Appurtenances
 - Mailboxes
 - Walks and steps
 - Driveways
- Utilities
 - Water
 - Sewer
 - Gas
 - Power
 - Telephone

Final Design

- Prepare Special Provisions
- Modify Standard Plans
- Add Plan Notes from PS&E

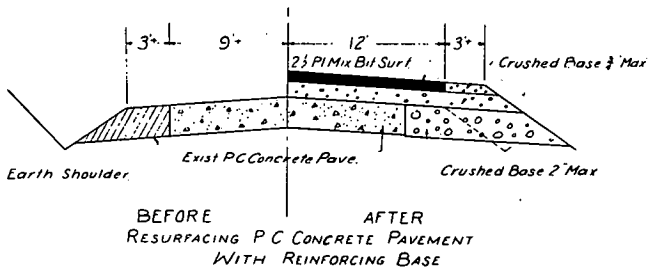
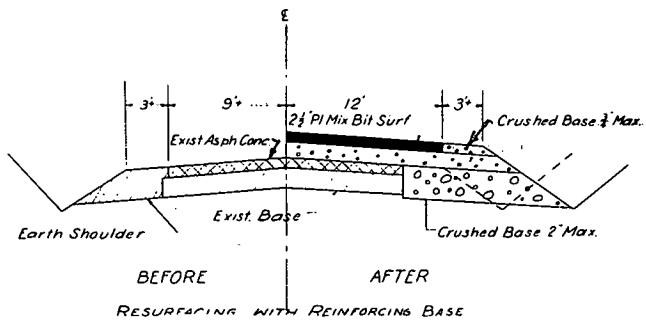
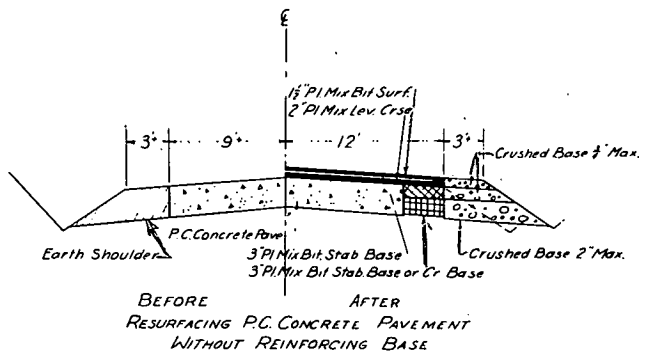
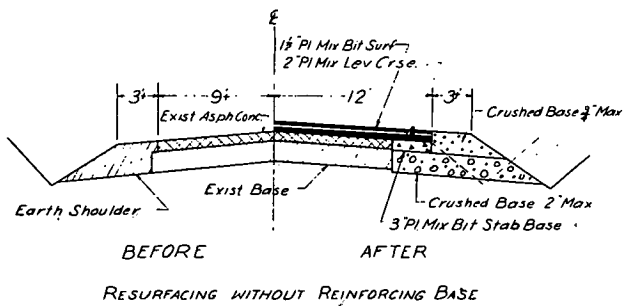
Construction

- Preconstruction Meeting
- Advance Notice to Public
- Coordination with Abutting Property Owners

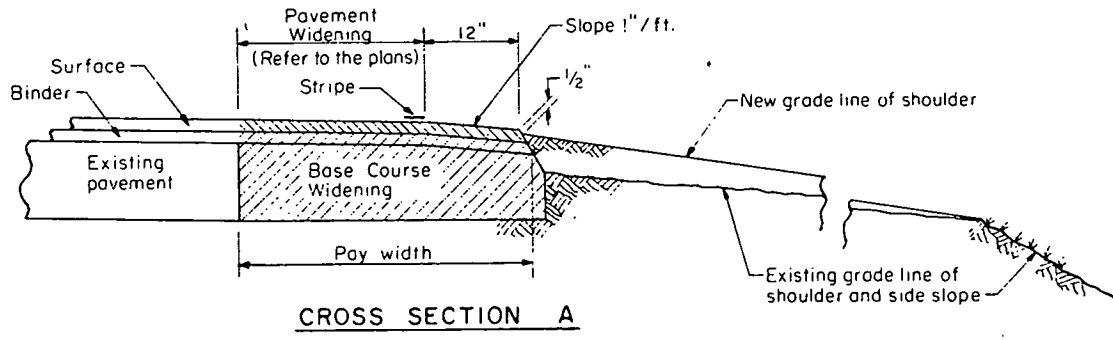
APPENDIX C

COLLECTION OF WIDENING PLANS

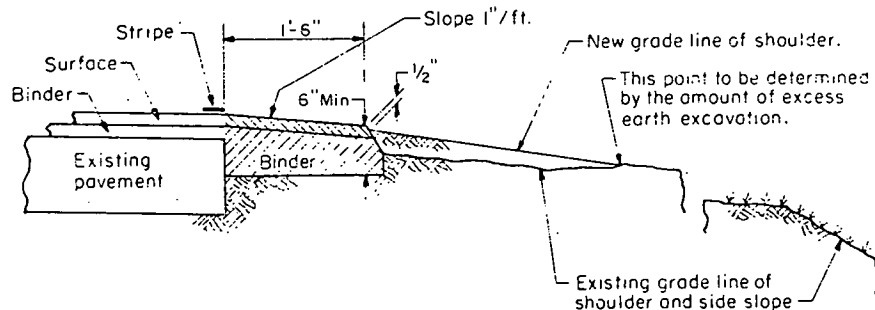
IDAHO



STANDARD DESIGN WIDENING AND SHOULDERS FOR PAVEMENT RESURFACING



CROSS SECTION A
DETAIL OF WIDENING WITH SHOULDER



CROSS SECTION B
DETAIL OF BITUMINOUS SHOULDER

GENERAL NOTES

Refer to the plans for the thickness of the bituminous binder and surface on pavement.

The Bituminous Binder shoulder material for Section B may be placed in one or two layers at the option of the Contractor.

The bituminous mixture for Section B shall be compacted to a density of not less than 85% of the theoretical density. The compaction equipment shall be as determined by the Engineer.

The bituminous binder and surface mixtures for shoulders will be paid for at the contract unit price per ton of the type specified for the adjacent resurfacing except that the thickness of surface course paid for will be limited to that specified for the resurfacing or 1 1/2 inches whichever is less. Surface course used in excess of this amount will be paid for as binder course.

The earthwork required as shown in Section A will be measured to the neat lines as shown and will be paid for at the contract unit price per cubic yard for EARTH EXCAVATION WIDENING which price shall include use of earth excavation to regrade the shoulders to the new grade line and disposal of excess as specified in the Standard Specifications.

The earthwork required as shown in Section B will be paid for at the contract unit price per unit (100 lineal feet) measured separately on the right and left hand sides for EXCAVATING AND GRADING EXISTING SHOULDER which price shall include use of excess earth excavation to regrade the shoulders to the new grade line.

Stripe at edge of pavement to be furnished by others.

STATE OF ILLINOIS
DEPARTMENT OF PUBLIC WORKS & BUILDINGS
DIVISION OF HIGHWAYS

ISSUED 5-10-67

REVISIONS

PASSED Dec 17 1971

W. Van Dine
Engineer of Road Plans and Contracts

APPROVED Dec 17 1971

W. E. Baumann
Engineer of Design

W.F. 12-1-69

W.F. 3-18-70

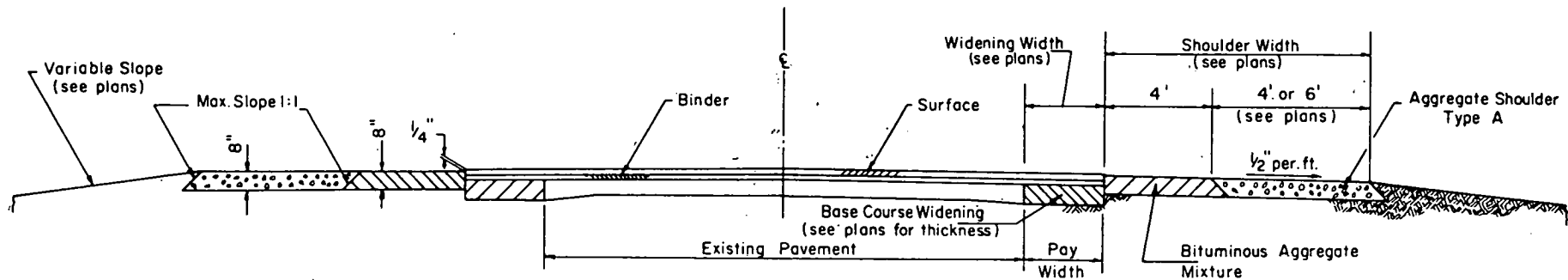
W.F. 1-18-71

W.F. 12-17-71

STANDARD 2239-5

STANDARD DESIGN

SHOULDER DETAILS FOR PAVEMENT WIDENING AND RESURFACING



GENERAL NOTES

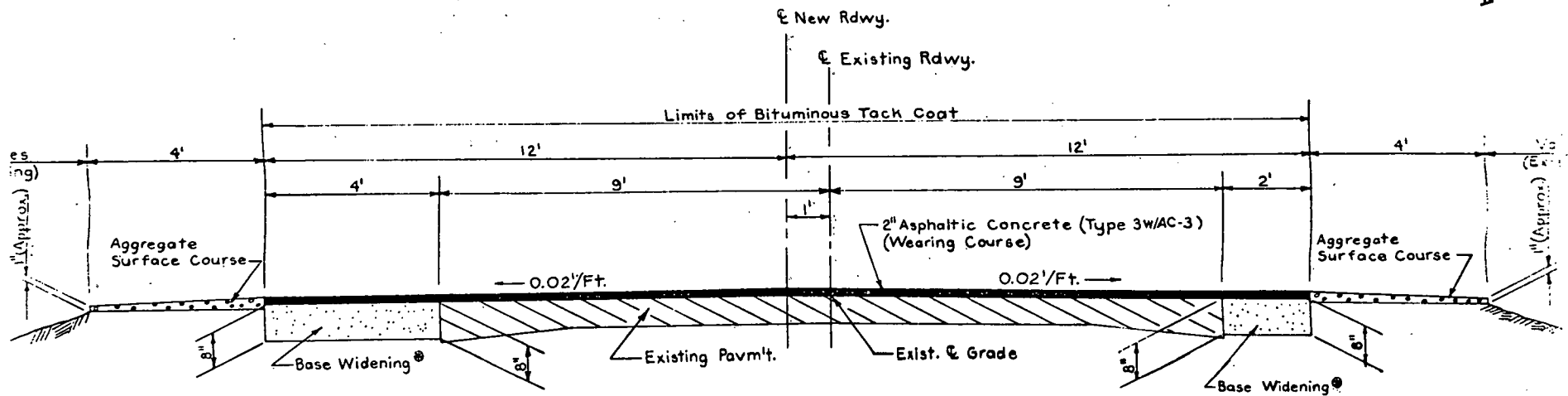
Refer to the plans for the thickness of the bituminous binder and surface on pavement.

The earthwork required for base course widening will be measured to the neat lines as shown and will be paid for at the contract unit price per cubic yard for EARTH EXCAVATION WIDENING which price shall include use of earth excavation to regrade the shoulders to the new grade line, and disposal of excess as specified in the Standard Specifications.

The earthwork required for shoulders and ditch slopes will be paid for at the contract unit price per unit (100 lineal feet) measured separately on the right and left hand sides for EXCAVATING AND GRADING EXISTING SHOULDER which price shall include use of excess earth excavation to regrade the shoulders to the new grade line, and disposal of excess as specified in the Standard Specifications.

STATE OF ILLINOIS		ISSUED 8-20-73	
DEPARTMENT OF TRANSPORTATION		REVISIONS	
PASSED	AUGUST 20 1973	DW.W.	8-20-73
<i>A. E. Deering</i> Engineer of Standards and Services			
APPROVED	AUGUST 20 1973		
<i>W. E. Bauman</i> Engineer of Design			

STANDARD 235I

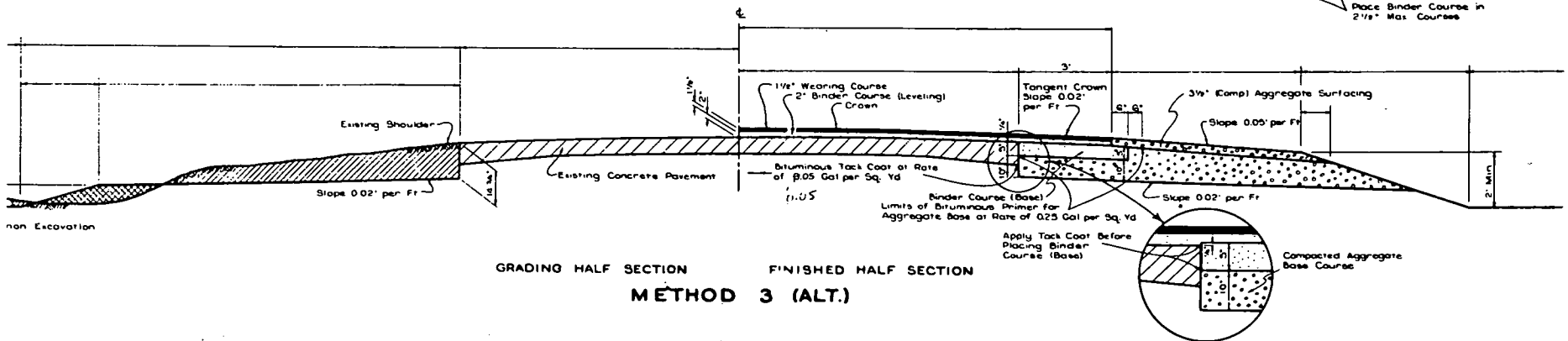
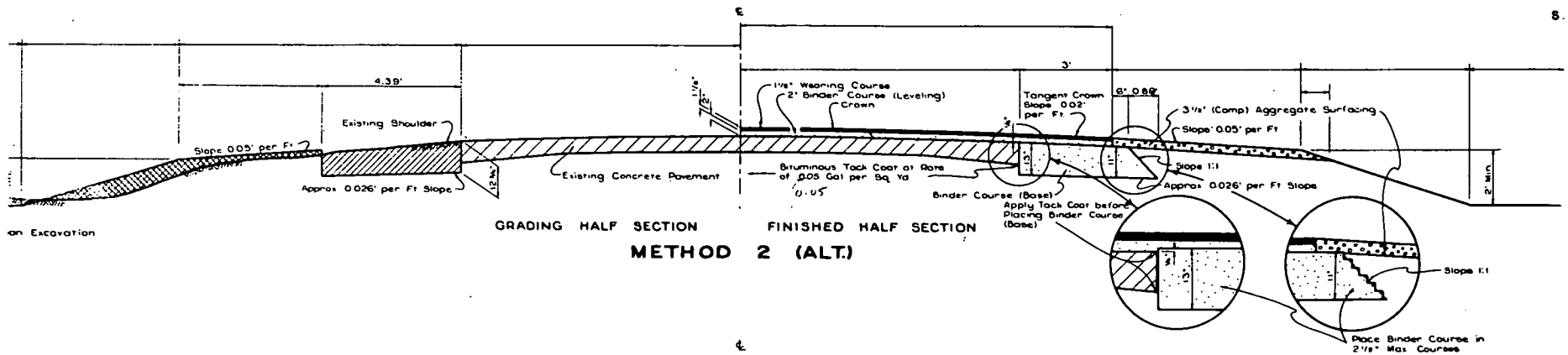
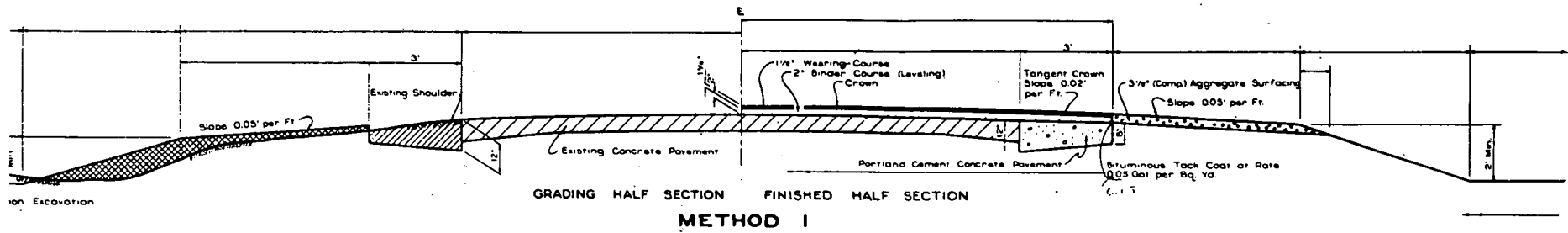


TYPICAL SECTION

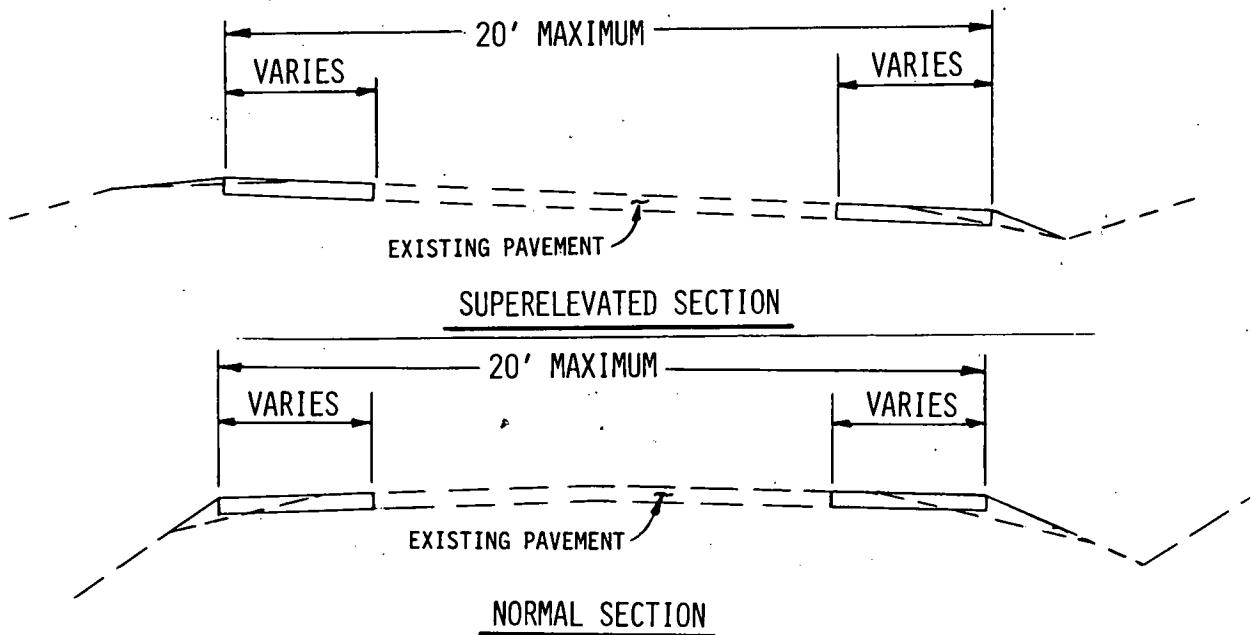
To Apply: Log Mile 39.80 to Log Mile 50.30

- Base Widening Shall Consist of: Asphaltic Concrete (Type 5A with AC-3) (Base Course) or Asphaltic Concrete (Type 1, 2 or 4w/AC-3) (Binder or Wearing Course)

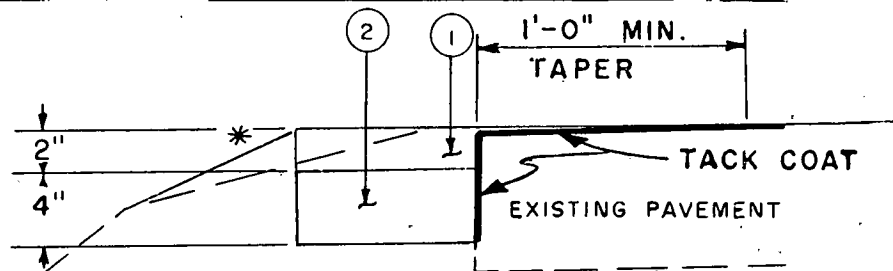
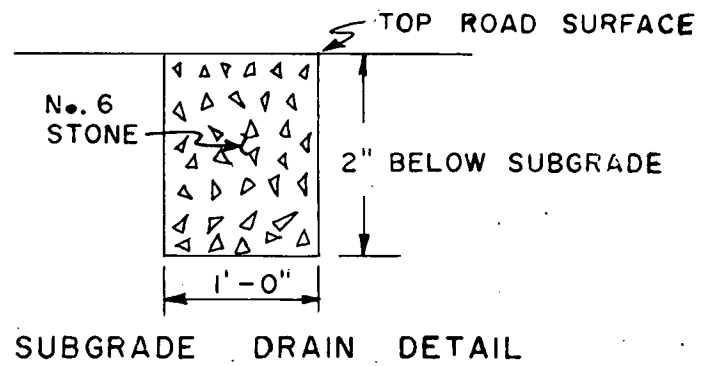
Notes: (1) Excavating Existing Shoulders shall be Paid for as Unclassified Excavation (Theoretical Quantity) Excess Material so Excavated shall be Disposed of along the Shoulders and Slopes or as Directed by the Project Engineer (No Direct Payment).
 (2) From Log Mile 39.80 to Log Mile 50.30, Existing Joints to be Cleaned and Resealed as Directed by the Project Engineer (No Direct Payment).

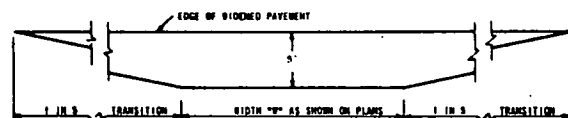


MARYLAND—FREDERICK COUNTY

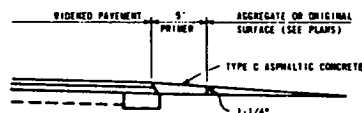


- ① 2" (NOMINAL) BITUMINOUS CONCRETE SPECIFICATION 'B' SURFACE COURSE USING BAND PC-1-61
- ② 4" (NOMINAL) BITUMINOUS CONCRETE SPECIFICATION 'B' BASE COURSE USING BAND P-3 (1 COURSE)

PAVEMENT DETAIL

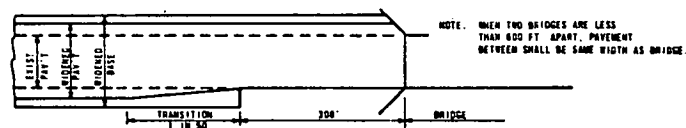


PLAN

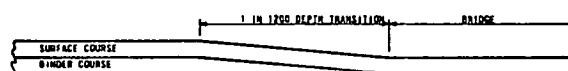


PROFILE

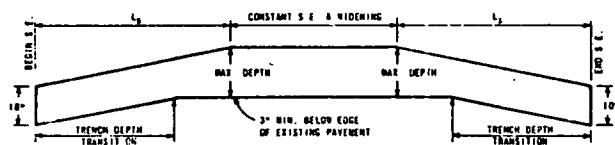
SURFACING REQUIREMENTS AT ENTRANCES & APPROACHES



WIDTH TRANSITION AT BRIDGE TO BE RESURFACED

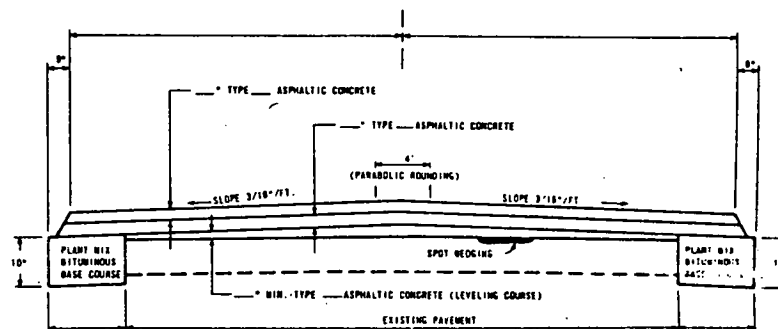


DEPTH TRANSITION AT BRIDGE TO BE RESURFACED

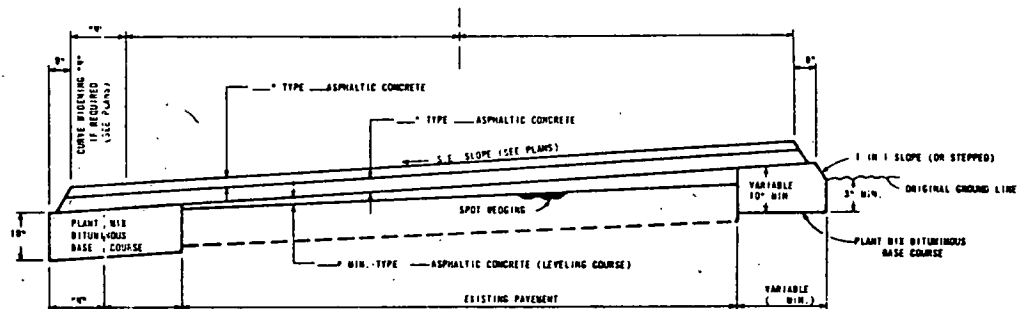


PROFILE

BASE WIDENING DEPTH TRANSITION ON OUTSIDE OF S.E. CURVES



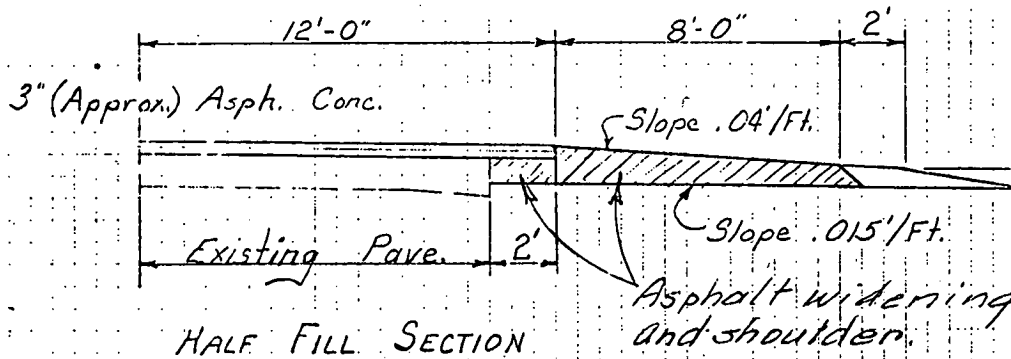
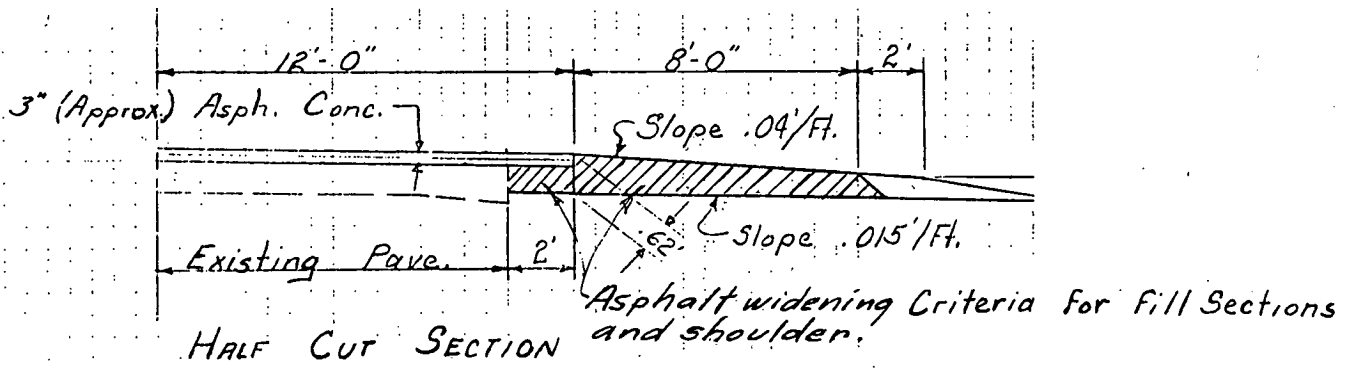
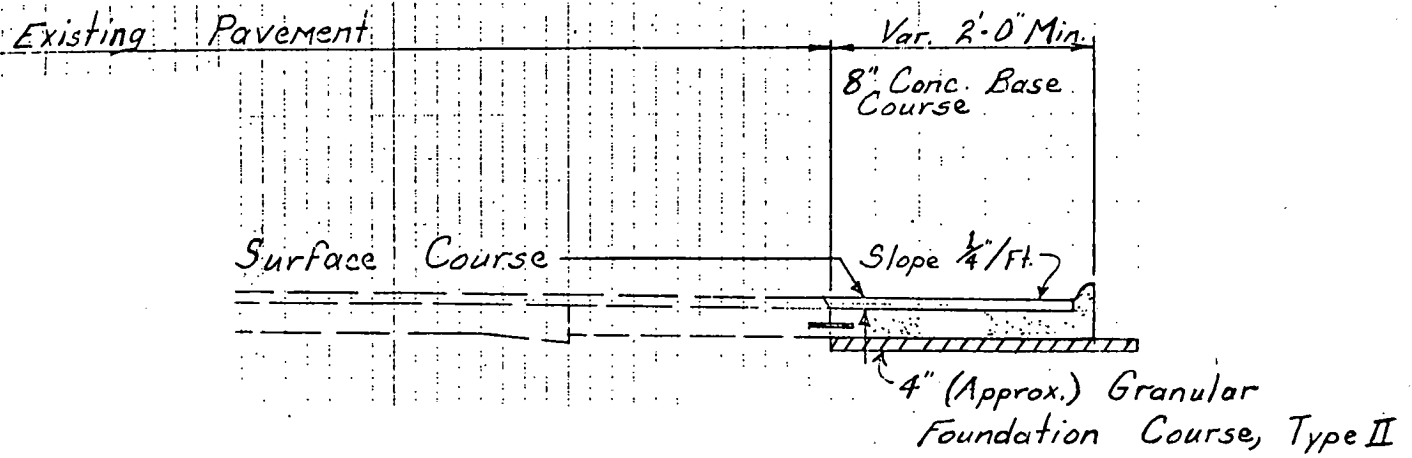
SECTION ON TANGENT

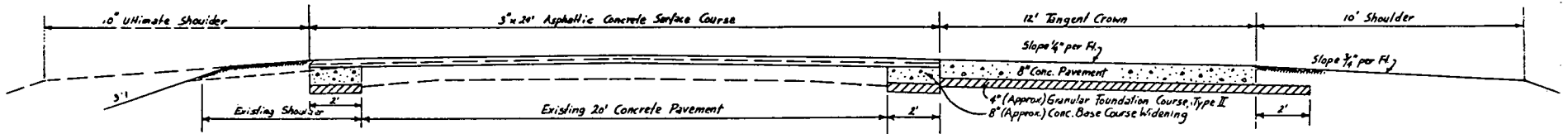
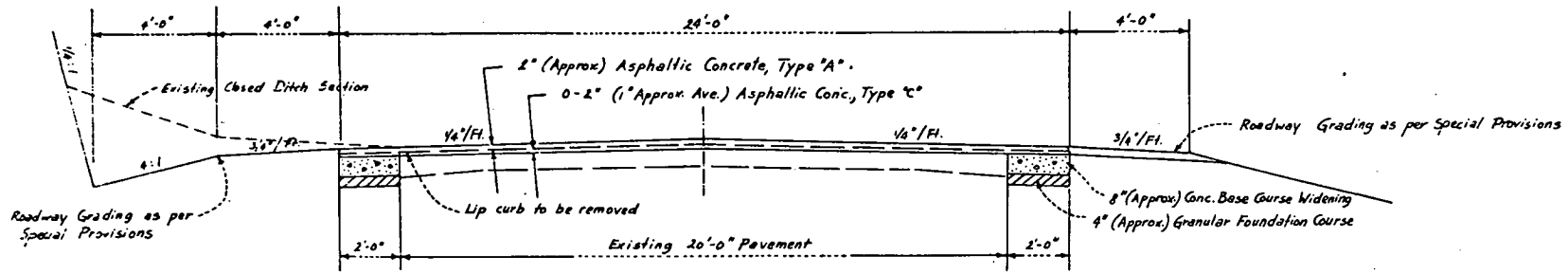
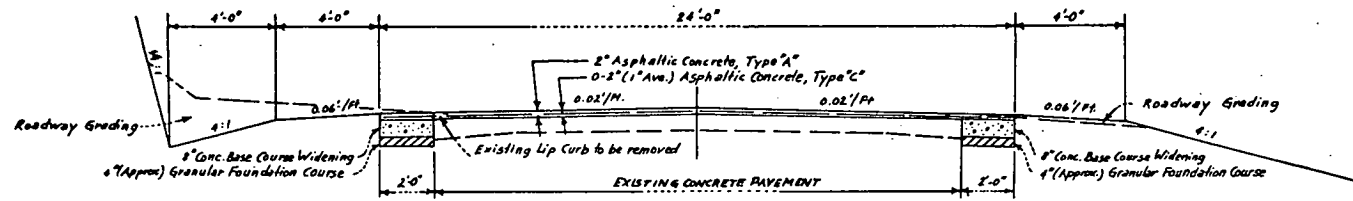


SECTION ON SUPERELEVATED CURVE

TYPICAL DETAILS
FOR
WIDENING AND RESURFACING

NEBRASKA





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