DEPARTMENT OF MAINTENANCE

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SALVAGING OLD PAVEMENTS BY RESURFACING

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SYNOPSIS

Beginning with 1949, all salvaged pavements in Iowa are being widened to 24 ft and, except for highways which have previously been widened in connection with roadside improvement projects, are being regraded to provide 10-ft shoulders, vertical curves and abrupt alignment are being corrected in many instances, low grades are being raised, in general bridges are being widened and raised if necessary to adjust to corrected grade lines, and culverts are being widened to correspond to the widened shoulders.

Two types of pavement widening are being used, (1) rolled stone topped with asphaltic concrete and (2) portland cement concrete Forms are used only when portland cement concrete is used both for widening and resurfacing The predominant type of resurfacing used the past two seasons has been asphaltic concrete, but in 1949 21 mi of integral widening and resurfacing with portland cement concrete have been placed.

For resurfacing with asphaltic concrete, the binder and surface courses are each 1½ in in thickness The design for replacement of the existing pavement when removed (1) for frost boil treatments is approximately 30 in. of rolled stone topped with 1½ in of black base plus binder and surface course and (2) for grade changes and relocations is 12 in of rolled stone topped with 1½ in of black base plus binder and surface course

For integral widening and resurfacing with portland cement concrete, the widened section is 10 in in depth and the depth over the existing pavement varies from 6 to 8 in in accordance with the condition of the old slab. The design for new pavement on grade changes and relocations is based on 10-9-10-in. thickness

In connection with resurfacing with asphaltic concrete two matters of general interest are receiving special attention, namely the treatment of cracks and joints in the existing pavement and the modification of some items of equipment

On the basis of limited experience, it has been concluded that, (1) both asphaltic concrete and portland cement resurfacings are justifiable but that both types of construction justify continued careful design and field study, and (2) continued friendly and cooperative study with equipment manufacturers in connection with the improvement of existing models or development of new items of equipment is desirable

Iowa is a fledgling in the field of pavement salvage, having now completed only two seasons of such work Hence, this paper is intended only to describe, as a matter of interest, what is being done along these lines. Iowa is interested in knowing what each of the other states has done or is doing in all fields of highway improvement

The experience of several other states in this field, in both design and construction practice, has been of great benefit to Iowa in her initial effort

The mileage which has been placed under contract to date is small indeed compared with those states with more adequate funds available for highways. Recently funds were made available and Iowa must materially enlarge her pavement salvage program as many miles of our early pavements are rapidly approaching their maximum life expectancy.

This paper will briefly describe the work which has been done, discuss a few matters which we believe will be of general interest and state a few conclusions which have been reached on the basis of our limited experience.

In 1948 some pavements were widened to

22 ft and some to 24 ft Beginning with 1949 it is anticipated that in the future all salvaged two-lane pavements will be widened to 24 ft In connection with widening and resurfacing, the highways, except those which previously have been widened as roadside improvement projects, are being regraded to provide 10-ft shoulders, vertical curves are being flattened in many instances, abrupt curvature is being corrected; low grade lines are being raised, bridges are being widened and raised if necessary to adjust to corrected grade lines, and culverts are being widened to correspond to the widened shoulders

PAVEMENT WIDENING

Two types of construction have been used in widening Iowa pavements; (1) rolled stone topped with asphaltic concrete and (2) portland cement concrete placed with and without forms. Since forms are used only when the new surface is also portland cement concrete, widening with forms will not be further discussed herein

Rolled Stone and Asphaltic Concrete—The normal designed thickness for this type of construction is 11 in exclusive of the binder and surface course—6 in. of compacted stone and 5 in of hot-mix asphaltic concrete. The total thickness of new base may be increased in accordance with subgrade soil stability to occasional depths of 17 in The extra thickness may be either rolled stone or asphaltic concrete, depending upon the sub-grade conditions encountered.

Specifications require that the stone be prewetted before it is placed in the trench, and since the stone must be deposited directly in the trench from the transporting vehicle, wet batching methods have been used On one contract a pug mixer of the continuous mix type was used and on another contract an abbreviated pug mixer designed and built by the contractor gave very satisfactory results In both cases the aggregate and moisture feeds through the mixer were coordinated to furnish the moisture content desired.

In normal thickness, the top 4 in of rolled stone are compacted to 100 percent Proctor density at optimum moisture with trench rollers. In a cooperative study between the Highway Commission and a firm manufacturing vibrators, a pilot model unit with four vibrators in tandem and mounted on a wheeled chassis was tested as a means to accelerate compaction of the stone However, the unit did not perform as anticipated in the tests and unless the manufacturer indicates a desire to continue the study, compaction by vibration in pavement widening will not be used in the near future.

In normal thickness, asphaltic concrete base must be compacted to a density of 97 to 100 percent of the laboratory density of the corresponding mixture

Prior to placing the new base, the normal subgrade is compacted with trench rollers until firm and free from distortion under the rollers Where the subgrade soil is unstable and extra depth of base is used, compaction of the subgrade is modified in accordance with its condition

Portland Cement Concrete—Portland cement concrete was used to widen 6 mi of pavement to be resurfaced with asphaltic hot-mix The design thickness was 9 in and in no case was the thickness increased Materials were proportioned at a central plant and mixed in transit mixers The shoulder adjacent to the existing pavement was trenched with a trenching machine and the final mix discharged into a form box which was pulled forward in the trench by the transit mixers A Maul vibrator was operated continuously in the form box and the widened section hand finished to the specified elevation immediately behind the form box The new base was coated with an emulsion curing agent and barred to traffic for 72 hr.

The new base was under traffic during the winter before the binder and surface courses were placed Traffic did not use the new base extensively, however, and this fact may account in part for rather extensive cracking which is now developing in the surface at the junction of the old pavement and new base

FROST BOILS, GRADE CHANGES AND RELOCATIONS

The design for replacement of the existing pavement at frost boils, grade changes and relocations is substantially as follows·

Frost Boils—At locations where the existing pavement shows abnormal distress due to subgrade soils fostering localized seasonal

heaving, the method of strengthening the new surface is dependent upon the type of resurfacing to be used. When portland cement concrete is used for widening and resurfacing, the new surface is thickened at such locations. When the new surface is to be asphaltic concrete the existing pavement is removed, the subgrade excavated to a depth of approximately 30 in. and the excavation backfilled with crushed stone as specified for use in widening the pavement The first 6 to 12 in. of granular material are compacted to the extent which the subgrade will permit without pumping and the remainder is compacted to 100 percent Proctor density at optimum moisture. Initially the granular fill was topped with 5 in. of hot-mix asphaltic concrete base but under present design the thickness of black base has been reduced to 1½ in

Grade Changes and Relocations—When portland cement concrete is used for widening and resurfacing the existing pavement, concrete pavement of standard design is used for grade changes and relocations When the existing pavement is resurfaced with asphaltic concrete the design for replacement of the existing pavement for grade changes and relocations initially involved 6 in of rolled stone base topped with 5 in of hot-mix asphaltic concrete. Under present design the rolled stone base has been increased to 12 in and the black base reduced to 1½ in. The stone base is compacted to 100 percent Proctor density at optimum moisture and the black base to the same density as specified for the black base used in widening the existing pavement, namely, a minimum of 97 percent of the laboratory density.

The normal 1½-in. binder and 1½-in. surface courses are added in all instances where reference is made to black base.

RESURFACING THE WIDENED PAVEMENT

Although the predominant type of resurfacing used to date has been hot-mix asphaltic concrete, the 1949 program included 21 mi. of portland cement concrete integral widening and resurfacing. This type of construction was selected for one of our heavier traffic routes on which the existing pavement had reached an advanced state of deterioration.

Resurfacing with Asphaltic Concrete—When asphaltic concrete is used for resurfacing, shattered concrete, spalled concrete and badly broken concrete are removed. Shattered and spalled concrete, if not extending through the full depth of the existing pavement, are replaced with hot-mix, and shattered concrete, if extending through the full depth of pavement, and badly broken concrete are replaced with portland cement concrete patches. Maul vibrators are used for all portland cement concrete patches.

Specifications require expansion joints and cracks 1 in. or more in width to be cleaned of bituminous filler and foreign material. Fine graded hot-mix is used to replace the material removed. Recently the requirements for portland cement patching and crack cleaning have been somewhat relaxed to the extent that only the particles that are loose are removed in shattered concrete, if the area is supported on all sides by the existing pavement and only unstable bituminous material is removed from cracks

Existing bituminous surface treatments and patches are removed from the existing pavement before resurfacing.

Integral curbs on the existing pavement are removed either by contract or by the Highway Commission. The Highway Commission has recently developed equipment for curb removal which permits removal of the curb at a very modest cost.

Four bituminous mixtures are permitted for base, strengthening, leveling, binder and surface courses varying from ½- to 1½-in. maximum particle size—¾- to 1-in. mixes are permitted in the binder course and ½- to ¾-in. mixes in the surface course. The bidder designates the mixture size on which his bid is based.

The binder and surface courses are compacted to 98 percent of the laboratory density for a corresponding mixture.

Resurfacing with Portland Cement Concrete—Although the 1949 program in which portland cement concrete was used for widening and resurfacing is not the first work of this type which has been done in the state, it is the first of this type involving appreciable mileage. Hence, it is not improbable that the design features which are briefly covered in subsequent paragraphs may be modified as work of this type continues

The principal work involved in the prepa-

ration of the old pavement prior to resurfacing consists of the removal of loose concrete, integral curbs and obsolete structures such as flume grates No crack cleaning is done and bituminous surface treatments and patches are disregarded.

The pavement salvaged by widening and resurfacing by this type of construction this season was 18 ft. in width of 10-7-10-in. design thickness. The pavement was widened to 24 ft and the design for salvage specifies a 10-in. thickness for the widened section and a thickness over the old slab varying from 6 to 8 in. in accordance with the condition of the existing pavement. For grade changes involving the removal of the existing pavement, the new design is based on the Iowa 10-9-10-in. thickness standard. Ten-inch forms were required since the thickness of the widened section was uniformly 10 in.

The salvage design specifies the use of a center parting strip and contraction joints spaced at 16-ft. intervals with 2-in. premolded strips at each joint.

The reinforcing plan specified is as follows:

1 *Principal Slab Reinforcement.* Welded wire fabric, 6- by 12-in mesh, No 4 wire in 11-ft -6-in. by 16-ft. sheets placed 2 in under the surface on either side of centerline and supported on a bed of concrete struck off from the forms with a steel-shod template.

2. *Center of Slab Reinforcement.* Dowels, ½-in. by 4-ft , at 2-ft centers below the mesh.

3. *Edge of Slab Reinforcement.* Longitudinal bars ⅝-in. by 16-ft. below the mesh and 9 in. from the outer edge; ½-in. by 4-ft. transverse bars spaced 1 ft and centered over the edge of existing pavement and below the mesh.

4. *Contraction Joint Reinforcement* A transverse bar, ⅝-in. by 11-ft.-6-in., below the mesh and on one side of the joint only as a substitute transverse member for the wire mesh principal slab reinforcement which was cut 1 in. from a transverse wire on one end and 11 in. on the other.

5 *Day's Work or Emergency Joint Reinforcement.* Transverse bars, ⅝-in. by 11-ft -6-in , on one or both sides of joint and below the mesh; ⅝-in. by 18-in transverse dowels at 15-in. centers below the mesh.

A wood header shaped to the pavement section is placed at the end of the day and is removed when paving is resumed. The curing requirements are those normally specified for portland cement concrete pavement.

Since the completed work has but recently been opened to traffic, no comments on its performance are offered at this time.

DISCUSSION

Our organization considers that the salvage of old pavements deserves the same careful engineering and investigational studies that have normally attended new construction to assure that the principles of durability, serviceability and economic use of public funds are preserved. A few matters which are presumed to be of general interest are discussed briefly in subsequent paragraphs.

Treatment of Cracks and Joints—The treatment for joints and cracks in the existing pavement as practiced or specified by several state highway departments has been found to be quite varied. It is presumed by our organization that the engineering principle involved concerns the cracking in the new surface. To this end our organization has recently designated experimental sections for current work on which cracks and joints shall receive varied treatments Since the experimental work has been but recently completed or is scheduled for 1950, no further comment is offered at this time.

Slab Underseal—Pumping pavement joints are a rarity in this state and as yet the economic justification of bituminous underseal prior to resurfacing has not been recognized

Expansion Joints for Bituminous Resurfacing—The design of an expansion joint for use in carrying asphaltic concrete surface courses over bridge floors has recently been completed. The design provides for a 1¼-in. by 1¼-in. bar to be welded on top of the existing 1½-in. by ½-in. bar on the pavement end and a strip of steel grid 7-⅝-in. by 1¼-in. to be welded on top of the existing 8-in. expansion plate. The open grid is to be filled with fine graded hot-mix and compacted in conjunction with normal surface rolling. One expansion joint somewhat different in design has been installed but no installations based on the foregoing design have yet been made.

Equipment Modification—As the result of a roundtable discussion at the end of our first season's pavement salvage operations Iowa

engineers considered that the modification of some items of construction equipment was practicable and desirable The items of equipment considered for modification included trench rollers, trench spreaders, continuous mixers and bituminous pavers The proposed modification and improvement in operation for each item follows:

1 *Trench Rollers and Trench Spreaders* In widening existing pavements with rolled stone topped with 5 in. of asphaltic concrete, the hot-mix is stepped in from 4 to 6 in from the outer edge of the rolled stone and hence has no edge support during compaction Excessive checking and spread occurred under the trench rollers as compared to the same mix used in the binder course As corrective measures, the equipment manufacturers concerned were requested to (1) provide means for partially compacting the hot-mix base material at the time of placement and (2) enlarge the compaction rolls on trench rollers The modifications proposed for the trench spreaders included provision for partial compaction of the hot-mix and for operation on the right-hand side of the pavement as a convenience to traffic

The three modifications proposed have been assured for the future by the manufacturers concerned and trench rollers of two makes with 60-in. diameter compaction rolls have been tested in our State during the current season. The contractor users have reported favorably on both units following limited use

2 *Bituminous Pavers.* The installation and removal of extensions for variable surface widths as required for one popular make of paver is time consuming. More often than not, the contractor was reluctant to remove an extension, if required, to permit installation of an edge beveling plate for the surface course if the extension would be required in the near future for the binder course for which an offset center joint is required A suggestion was made to the manufacturer that the normal width of the paver be increased from 10 to 12 ft. with cutoff shoes used for courses less than 24 ft in width

No assurance was given by the manufacturer that the suggested modification would be made as it was considered that corrective measures for variable surface widths would require complete redesign of the unit

3. *Continuous Mixers.* During the first season's work on projects employing continuous type mixers a nonuniform texture of the surface course caused some concern due to segregation of the larger particles during discharge into the transporting trucks The effectiveness of hand raking in eliminating this discrepancy was variable and dependent upon numerous personal factors

Contact was made with the manufacturer of the equipment requesting that means be provided to overcome this objectionable feature. We were advised that a study of means to solve this problem was already under way, and during the current season users of continuous type mixers installed supplementary equipment purchased from the manufacturer which was reasonably satisfactory in correcting objectionable segregation

Several other highway departments with more experience in pavement salvage operations were contacted to determine if they were in accord with our views on needed equipment modification

From the replies received, it was learned that, of those states employing construction types and methods similar to those used in Iowa, a majority was in agreement that equipment modification in some degree would be desirable. In a couple of instances replies indicated definite disagreement in whole or part with our views in the matter

CONCLUSIONS

We do not doubt but that those states with several years of experience in pavement salvage operations have largely eliminated doubtful features as to types, design and construction methods. On the basis of the limited amount of work which Iowa has completed to date, it is concluded that.

1. Resurfacing with both asphaltic concrete and portland cement concrete is justifiable both from the standpoints of good engineering and economics—determination of type to be based upon the condition of the existing pavement at time of salvage.

2 In the use of portland cement concrete for integral widening and resurfacing, design details as to thickness and reinforcement justify continued study

3. In the use of asphaltic concrete for resurfacing numerous details justify careful design and field study coupled with well planned research to include·

(a) The type and design of new base for

widening existing pavements with respect to cost, durability, distortion and minimum separation of the new and old bases during the life of the improvement.

(b) The economical and practical treatments of unstable subgrades in connection with pavement widening.

(c) The extent to which the repair of the existing pavement at the time of resurfacing is justified

(d) The treatment of cracks and joints in the existing pavement prior to resurfacing to assure a minimum of carry-through to the new surface.

(e) The question of justification for removal of old bituminous surface treatments from the existing pavement prior to resurfacing.

4 Continued friendly and cooperative study with equipment manufacturers in connection with the improvement of existing models or development of new items of equipment for use in pavement salvage is justified and desirable

SECONDARY ROAD SURFACING PROBLEMS IN IOWA

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SYNOPSIS

This paper reports some observations and conclusions of a joint committee of County Engineers and Engineers of the Iowa Highway Commission that has been studying the secondary road surfacing problems for the past five years The problem is that of building and maintaining 79,000 miles of all-weather roads in a glacial territory for a uniformly distributed population that has a high cultural development This must be accomplished in the face of a growing scarcity of material sources and the consequent rapid depletion of known deposits of road-building materials

The County Engineers' Association recognized this problem and requested the assistance of the Highway Commission in its solution As a result a Joint Committee of County Engineers and Highway Commission Engineers was formed to direct the solution of the problem This Committee has been active in the promotion of the stabilization of the local materials available in the various counties The Committee was also active in the development of a bill "for an Act to Establish a fund for financing engineering studies and research projects in connection with construction and maintenance of secondary roads " This bill, under the sponsorship of the County Engineers' Association, became a law by act of the last legislature

A total of 3,095 miles of secondary roads were newly surfaced in Iowa during the last year The problem of material resources is illustrated by the fact that the material required for this new construction, plus that required for the maintenance of previously surfaced roads, would require a volume equal to a depth of almost 7 feet over an area one mile square. We are now passing out of the pioneer stage and a more rapid exploitation of present resources by expanding production will only aggravate the situation

Any truly economical solution of the secondary road surfacing problem in Iowa must be based upon thorough field and laboratory studies of local conditions to evaluate the effect of such factors as the type of subgrade soil and its drainage requirements, to guide in the proper selection and use of subgrade soils and of stabilizing materials, and to give consideration to new processes and methods of construction It will also require the help of trained geologists, prospecting for new sources with specialized equipment and methods, and the continued cooperation of all our road administrators

The demand for all-weather secondary roads and the rapid depletion of surfacing material sources in Iowa is causing our Secondary Road Administrators—the County Boards of Supervisors and the County Engineers—a great deal of concern. This concern is not so much for the present as for the future.

The Secondary System of Iowa has some