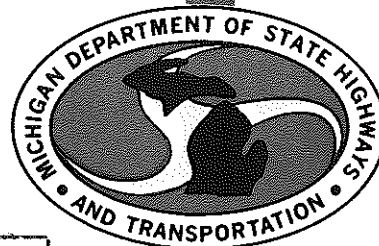


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USE OF RECYCLED ASPHALT SURFACE MATERIAL
IN THE CONSTRUCTION OF A BITUMINOUS
STABILIZED BASE, I 75, CHEBOYGAN COUNTY

Construction Report



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**TESTING AND RESEARCH DIVISION
RESEARCH LABORATORY SECTION**

USE OF RECYCLED ASPHALT SURFACE MATERIAL
IN THE CONSTRUCTION OF A BITUMINOUS
STABILIZED BASE, I 75, CHEBOYGAN COUNTY

Construction Report

J. H. DeFoe
G. F. Sweeney

Research Laboratory Section
Testing and Research Division
Research Project 75 D-30
Research Report No. R-1088

Michigan State Highway Commission
Peter B. Fletcher, Chairman; Carl V. Pellonpaa,
Vice-Chairman; Hannes Meyers, Jr., Weston E. Vivian
John P. Woodford, Director
Lansing, April 1978

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The concept of re-using highway construction materials began in the Michigan Department of State Highways and Transportation about 10 years ago with an experimental shoulder reconstruction project in Genesee and Saginaw Counties (1). Twenty-one miles of Interstate shoulders were reconstructed in five experimental sections using different liquid bituminous binders to stabilize existing gravel materials by mixed-in-place procedures.

Even though this first project successfully demonstrated the effectiveness of such methods for reconstructing highway shoulders, the need for specifications and quantitative design guidelines also became apparent. Recommendations resulting from this first project called for further research to determine design criteria, as well as desirable properties of both the bituminous admixtures and the potential base materials to be reworked. In February 1972, the Research Laboratory initiated a research project designed to satisfy these needs (2).

The purpose of the research study was to obtain additional information concerning the design of asphalt-aggregate combinations when stabilized in-place for reconstructing existing shoulders and bases. The study emphasized the use of existing base materials as well as the reclaiming of old asphalt surfaces and incorporating them into the resultant base layer. Results obtained from the laboratory phase of this study, reported in June 1974, formed the basis for expanded use of the mixed-in-place concept for shoulder and base reconstruction (3). The final phase of this study, conducted during 1974-75, involved both field and laboratory evaluations on eight major reconstruction projects along Interstate and primary highways (4). In all, more than 370,000 tons of recycled base material were processed in-place on these eight projects.

The need for action to correct roughness and surface deterioration on I 75 in Cheboygan County (Fig. 1) became evident during the spring of 1975 when a mean Present Serviceability Index of 1.05 was measured. Serviceability values of 2.5 for major highways and 2.0 for lower traffic volume highways, respectively, require corrective action according to current AASHTO guidelines (5).

The existing pavement was constructed between 1960 and 1962 using 25 in. of sand subbase, 11 in. of aggregate base, and approximately 4-1/2 in. of bituminous concrete binder, leveling, and wearing courses. The bituminous paving was constructed with 60/70 penetration grade asphalt cement which became harder and more brittle with age and during cold weather. The resulting cracks permitted moisture to enter the base causing localized heaving and general deterioration of the pavement resulting in the low serviceability rating.

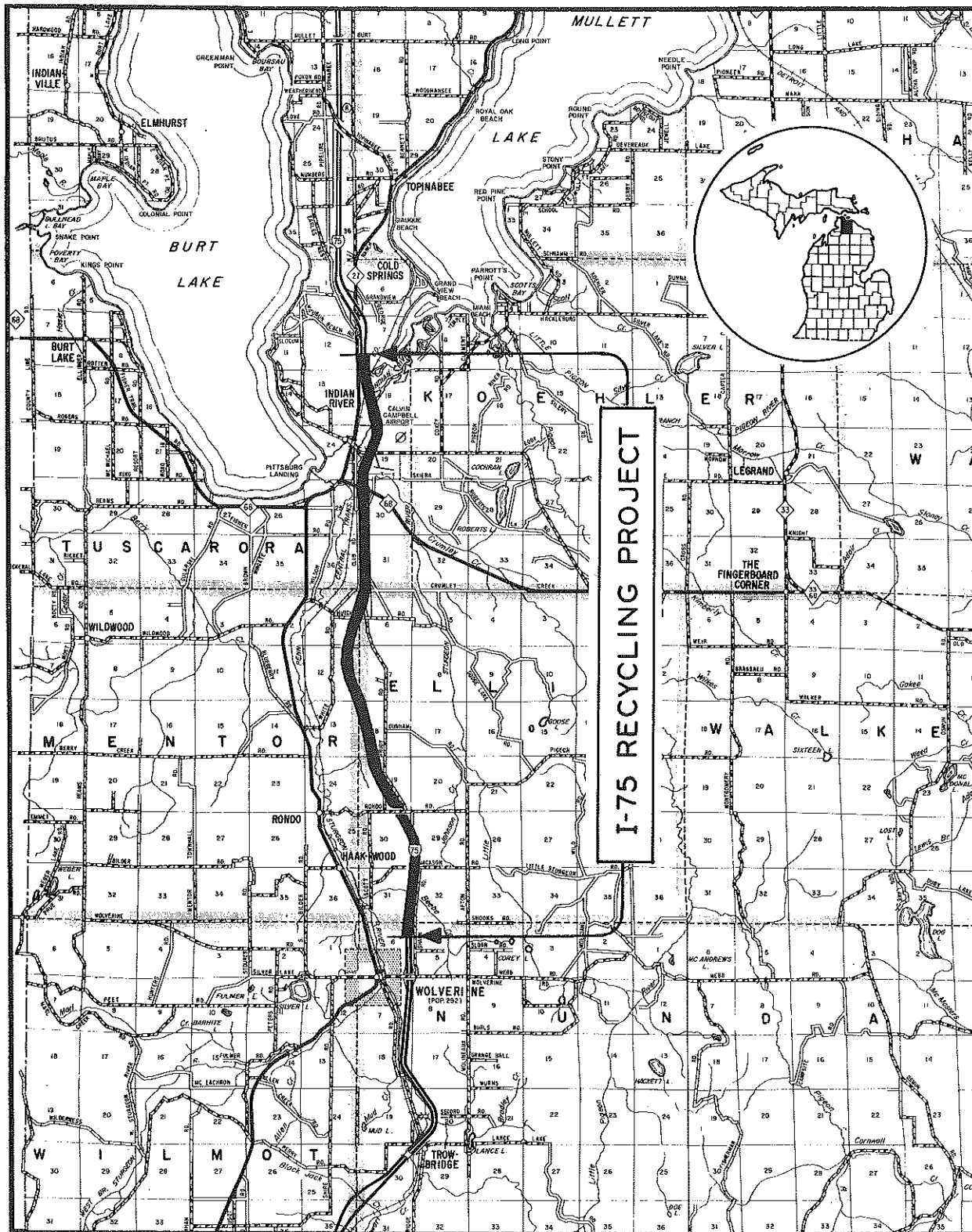


Figure 1. Location of recycling project, I 75 in Cheboygan County.

Two methods of rehabilitation were considered for the reconstruction of this 11-mile section of highway which would minimize reflective cracking as well as provide a smooth riding surface. The southbound roadway was selected for reconstruction incorporating a 2-in. separation course (a hot mix bituminous base course) surfaced with leveling and wearing courses totaling 2-1/4 in. in thickness.

Recycling, by pulverizing and stabilizing the existing bituminous pavement was selected for the northbound roadway and is the subject of this report; however, performance comparisons will be made between the northbound roadway reconstructed by recycling and the southbound roadway involving a separation course.

In August 1975 the Federal Highway Administration approved Experimental Work Plan No. 41, MDSHT Research Project 75 D-30, qualifying the job as a Category 2 Experimental Project. Final preparations proceeded and included the sampling and laboratory testing of materials from the road, documenting existing road conditions, and writing specifications for the recycling, based on experience gained from past projects. Work on the project was started in April 1977 by the prime contractor; Lake Construction of Indian River. The subcontractor for recycling the old pavement was Woodland Paving of Comstock Park, Michigan.

The purpose of this report is to describe the construction of the recycled roadway with emphasis on equipment, operations, and material involved. A later report will present the physical characteristics of the resultant materials along with in-service performance evaluations.

Pre-Construction Evaluation

Prior to construction, samples of existing bituminous surfacing and aggregate base material were obtained and evaluated to determine proper density levels and the appropriate asphalt type and amount for stabilization. The samples consisted of bituminous concrete surfacing, taken from the driving lanes, as well as shoulder base aggregate. In preparation for testing, the bituminous concrete was crushed to a maximum size of 2 in. and blended with the shoulder aggregate in the same proportion expected to result from mixing methods to be used on the project.

Tests were conducted in the Research Laboratory to evaluate the effectiveness of four different asphalts as potential stabilizers of the pulverized material (4). Two asphalt cements, along with an emulsion and a cutback, all typical of materials available in the state, were used in the tests. Based on the results of these tests it was decided that either an

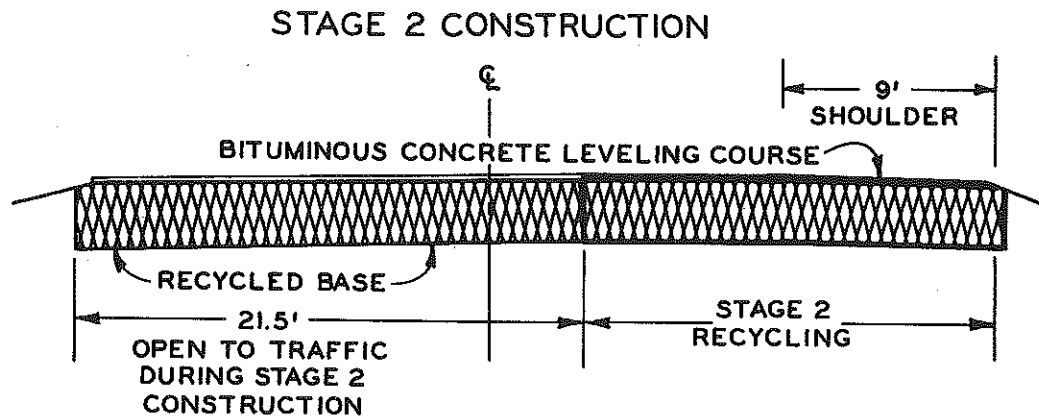
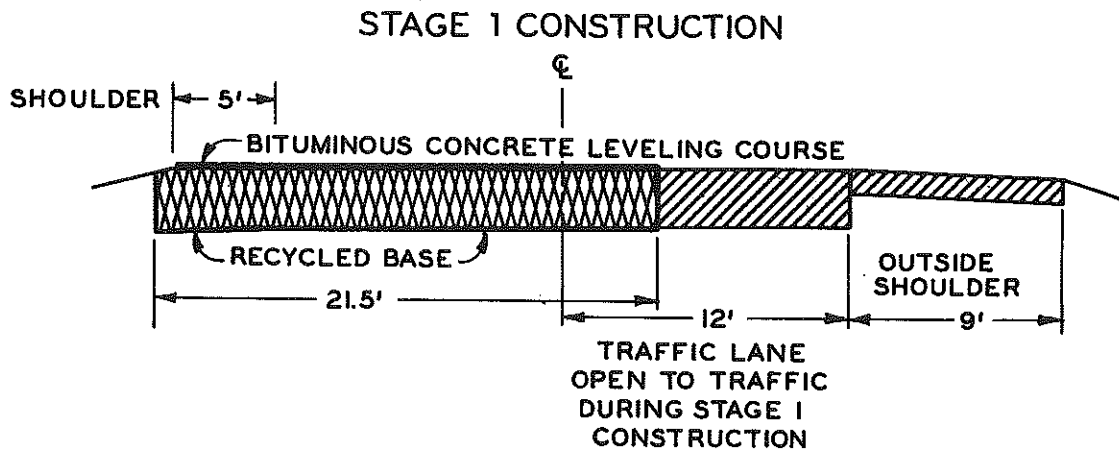
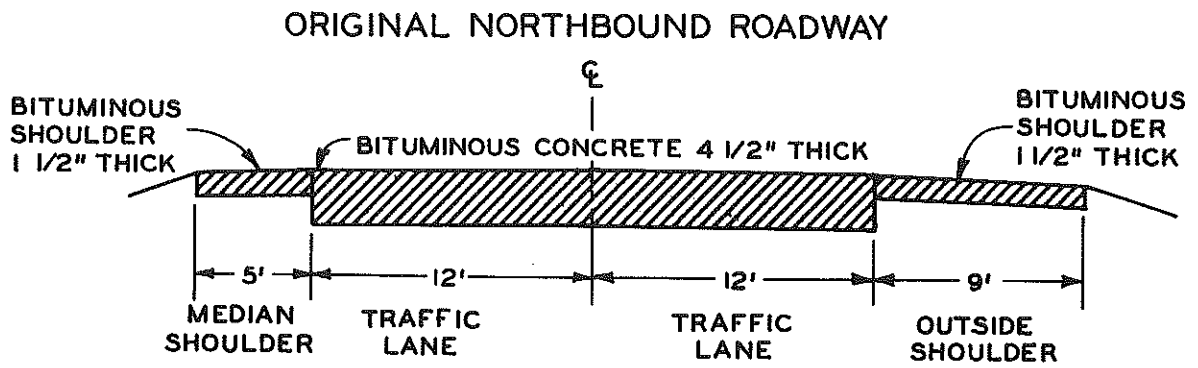


Figure 2. Major stages of recycling, I 75 in Cheboygan County. The third and final stage consisted of a bituminous concrete wearing course placed over the 38 ft roadway.

asphalt cement of 120/150 penetration grade or an MC-800 cutback would be used as a stabilizer; the amount to be added would not exceed 5 percent by weight of the bituminous mixture.

A compaction requirement calling for the density of the recycled material to be 98 percent of AASHTO T-180 was also selected from the results of these laboratory tests (4).

These recommendations were incorporated in the "Special Provisions for Bituminous Aggregate Base Course Stabilized In-Place" along with other requirements established as the result of past mixed-in-place construction projects. This Special Provision, along with the section of the 1976 Standard Specifications for Highway Construction applicable to this project are included as an Appendix to this report.

Construction Procedure

To maintain traffic during construction, recycling of the asphalt concrete pavement was conducted in three stages involving approximately one-half of the roadway at a time; one lane of traffic was allowed on the other half as shown in Figure 2. In Stage 1 the portion of the roadway comprised of the passing lane and median shoulder was recycled and paved with a leveling course for the entire length. Similarly, Stage 2 involved the other half of the northbound roadway with traffic directed to the newly paved passing lane. Finally, Stage 3 consisted of paving the full width, 38 ft, with a wearing course. Recycling consisted of: 1) pulverizing the existing 4-1/2 in. of asphalt concrete, 2) stabilizing by mixing asphalt cement into the crushed material, 3) compacting the mixture and 4) trimming the compacted base to the desired cross-section. The various steps in this recycling method are shown diagrammatically in Figure 3.

Pulverizing the existing bituminous concrete began on June 22, 1977, and required two cuts to crush the full 4-1/2 in. depth. The first cut, made with a CMI 750 Rotomill, pulverized the top 2-1/2 in. of material and placed it in a windrow alongside the roadway. A second cut, made with a Pettibone 660 hammermill, crushed the remaining 2 in. of bituminous concrete (Fig. 4). The cutting width of the CMI and Pettibone machines are about 8 and 4 ft, respectively, so that two passes of the CMI and four passes with the Pettibone were needed to crush one half the width of the roadway. Shoulders required additional passes with the Pettibone. After the crushing operation was completed, the material was bladed back to a smooth level cross-section. The crushed material was well graded and contained only a few pieces larger than the 2 in. specified size (Fig. 5).

SEQUENCE OF CONSTRUCTION OPERATIONS

- ① Pulverize median shoulder.
(Pettibone Hammermill)
- ② Pulverize one-half of passing lane along median.
(Rotomill followed by Hammermill)
- ③ Pulverize remainder of passing lane.
(Rotomill followed by Hammermill)
- ④ Shape to uniform cross slope and grade.
(Grader)
- ⑤ Stabilize (add asphalt) reshape and compact.
(Single-pass stabilizer followed by grader and roller)
- ⑥ Grade to plan cross-section and final compact.
(Autograder followed by rollers)
- ⑦ Pave leveling course to complete Stage 1 construction.

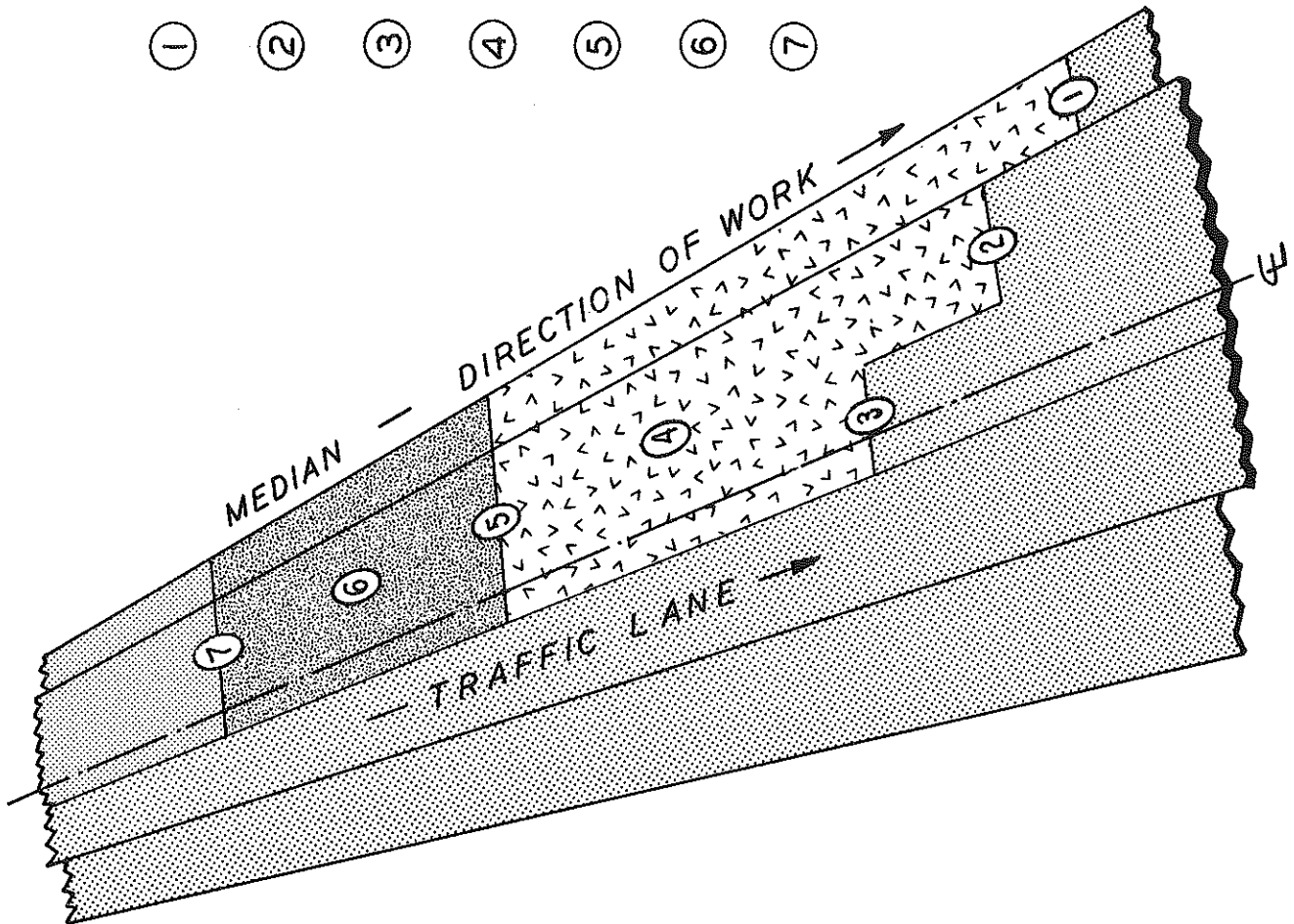
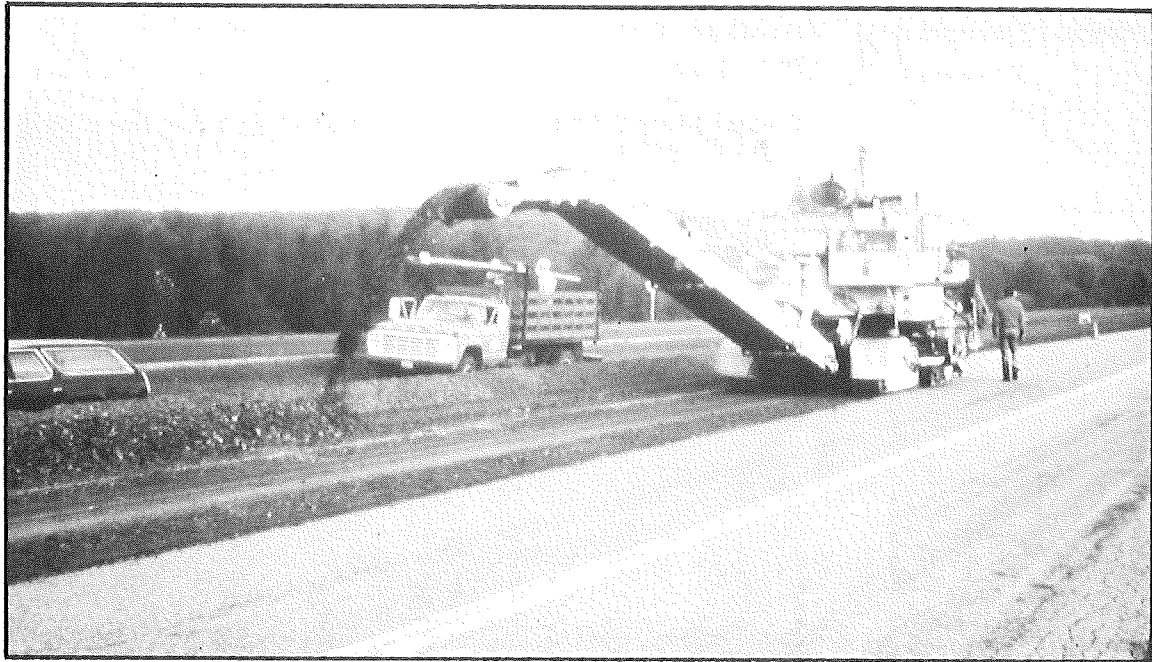


Figure 3. Sequence of Stage 1. Construction operations involved in the recycling of I 75.



CMI Roto-mill crushing the top 2-1/2 in. of bituminous concrete.



Pettibone hammermill crushing the remaining 2 in. of bituminous concrete.

Figure 4. Pulverizing the existing 4-1/2 in. of bituminous concrete.

Sieve Size	Percent Passing
2-in.	100.0
3/4-in.	75.6
1/2-in.	63.8
3/8-in.	53.6
4	36.3
8	25.1
16	18.0
30	13.3
50	7.3
100	2.3
200	1.1

Gradation of pulverized bituminous concrete prior to stabilization.



Windrow of crushed bituminous concrete from CMI Roto-mill.

Figure 5. Pulverized bituminous concrete on I 75, Cheboygan County.

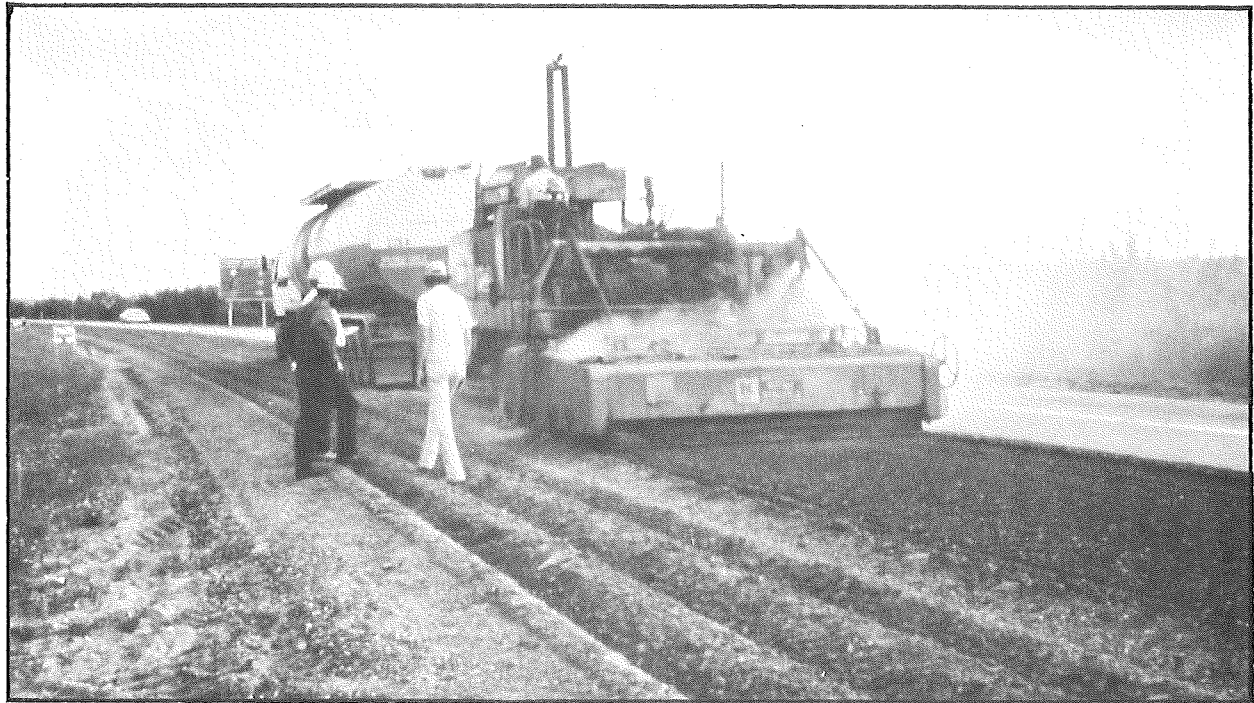


Figure 6. Stabilization of pulverized bituminous concrete with asphalt cement through a single-pass stabilization machine.

Crushing operations were hampered by numerous mechanical breakdowns of the CMI Rotomill, which occurred once or twice a day and were major causes of delay. By the end of the job, however, most of the mechanical problems had been resolved and the crusher was working at near-maximum capacity. The Pettibone hammermill, used to pulverize the bottom 2 in. of bituminous concrete, operated with few mechanical problems.

The crushed mixture was stabilized with a penetration grade asphalt cement at an average application rate of 1.2 gal/sq yd. This type of stabilizing agent was chosen because, unlike cutback asphalt, it requires no curing time and is, therefore, a faster, more efficient additive.

The project was started using a 120/150 penetration grade asphalt at 335 F. After some mixing difficulties became apparent, it was decided that 200/250 penetration asphalt at 370 F would produce a better mixture, so about half way through the job, a switch was made to the softer asphalt. The stabilizing agent was introduced into the crushed material with a single pass P and H stabilizer resulting in a uniform mixture (Fig. 6). The pulverized material was not heated prior to adding the asphalt cement. At the request of the Construction Division, the base of the final 6,000 ft (approximately) of the north end of the job was recycled without the addition of fresh asphalt. Locations of the different test sections are shown in Figure 7.

Moisture content of the material to be stabilized was found to be critical to achieving a uniform mix. From the various moisture contents determined in unstable areas, it was found that moisture levels near 7.0 percent were excessive and such material should be dried prior to adding the asphalt stabilizer. It was also found, by determining moisture contents in several dry areas, that moisture levels below 4.0 percent were not suitable for obtaining a uniform mixture. Poorly mixed areas of asphalt and fines were very evident when the material to be stabilized was too dry. During the project, it became necessary either to add water to the pulverized material or to aerate it, depending upon the moisture content.

Immediately after the asphalt had been mixed into the base material, compaction operations were begun. Compaction of the stabilized mixture was accomplished with one rubber-tired roller and two vibratory rollers. Initial compaction was accomplished by the rubber-tired roller operating directly behind the P and H stabilizer. When the rubber-tired roller had completed its initial compaction, the surface was graded to the desired shape, after which the first vibratory roller compacted the material further. This was followed by the trimming operation, and finally, a second vibratory roller was used to compact the grade to specified density, 98 percent of standard density obtained using the AASHTO T-180 method. A

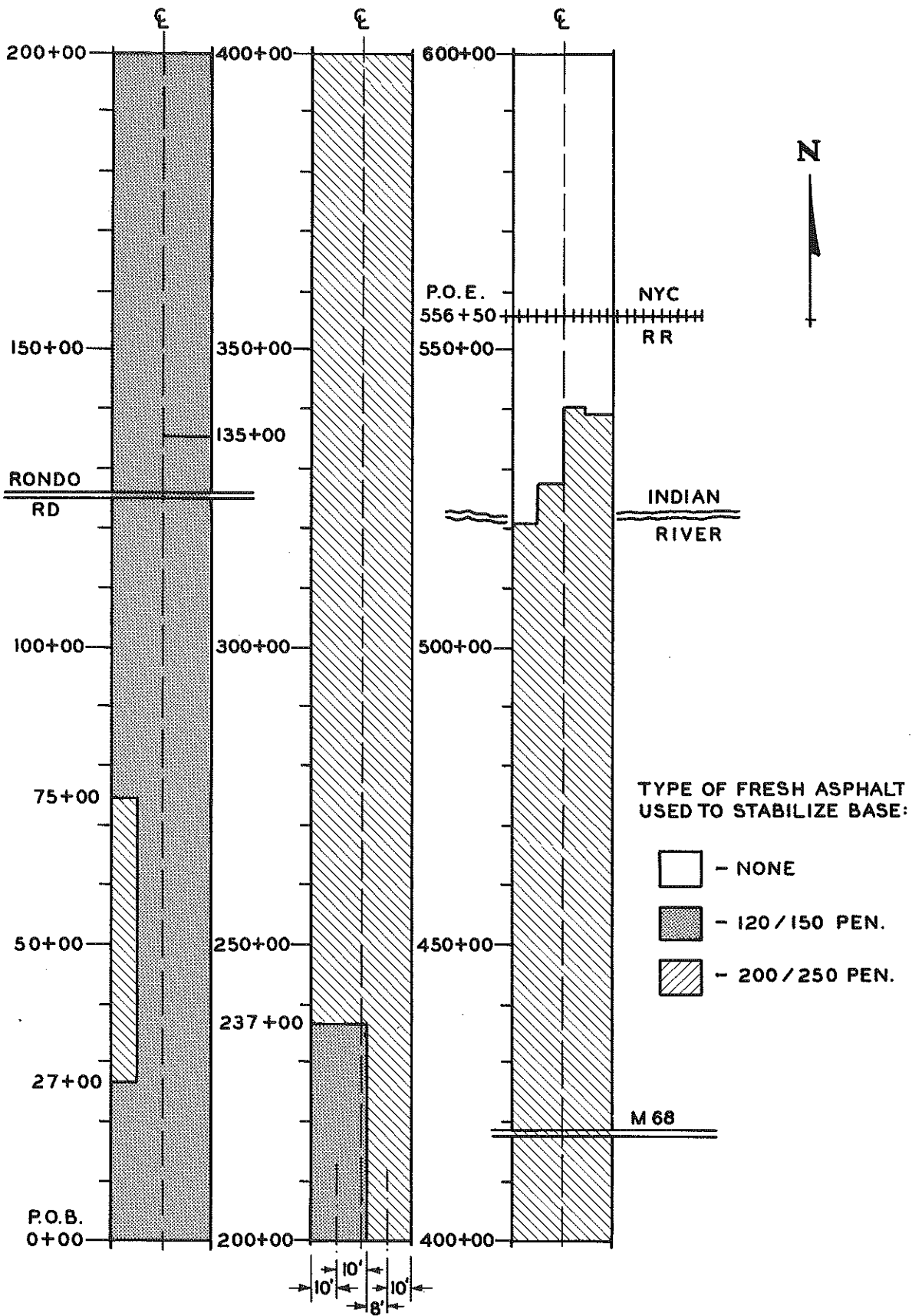


Figure 7. Location of the test sections.

summary of T-180 design densities, in-place densities, and percent compaction is presented in Table 1. The in-place densities were determined with a Troxler nuclear gage using the 4-in. direct transmission mode of operation. There were no unusual problems during density control of the job, even with the use of different grades of asphalt cement and the variation in moisture content.

TABLE 1
COMPACTION DATA OF RECYCLED BITUMINOUS
CONCRETE BASE MATERIAL

Stabilizing Agent	T-180 Design Density			In-Place Compaction Data			
	Average, lb/cu ft	Standard Deviation	No. of Tests	Average Density, lb/cu ft	Percent of Design (T-180) Density	Standard Deviation	No. of Tests
120/150 penetration	128.13	5.18	24	128.91	100.61	2.10	197
200/250 penetration	131.47	2.78	20	132.19	100.55	1.93	400
No bitumen added	129.95	3.46	2	131.41	101.12	2.56	28

Trimming the stabilized base to the specified grade conducted between the first and second vibratory roller operations was accomplished by an autograder making two passes for each half of the roadway (Fig. 8). The grade was controlled by a 30-ft ski riding on the adjacent grade. The first pass was made at the centerline of the roadway, after which a second pass was made on the outer side of the roadway using a center lane as the reference grade. With the type of equipment used, it was very hard to control the grade because in some areas it was necessary to cut large quantities of material and waste it while in other areas the grade was too low to cut at all. Although this method of trimming was successful, it was felt that modifications would be needed on future recycling jobs.

After the grade was compacted and trimmed, bituminous concrete leveling and wearing courses were applied. After the leveling course was paved, it was several weeks before the wearing course was applied. This time lag afforded an opportunity to observe any weak base area that might have been exposed by normal traffic loads. No such areas were evident during the month before application of the wearing course.

Construction Problems

In general, all construction operations were conducted successfully and a satisfactory end product obtained.

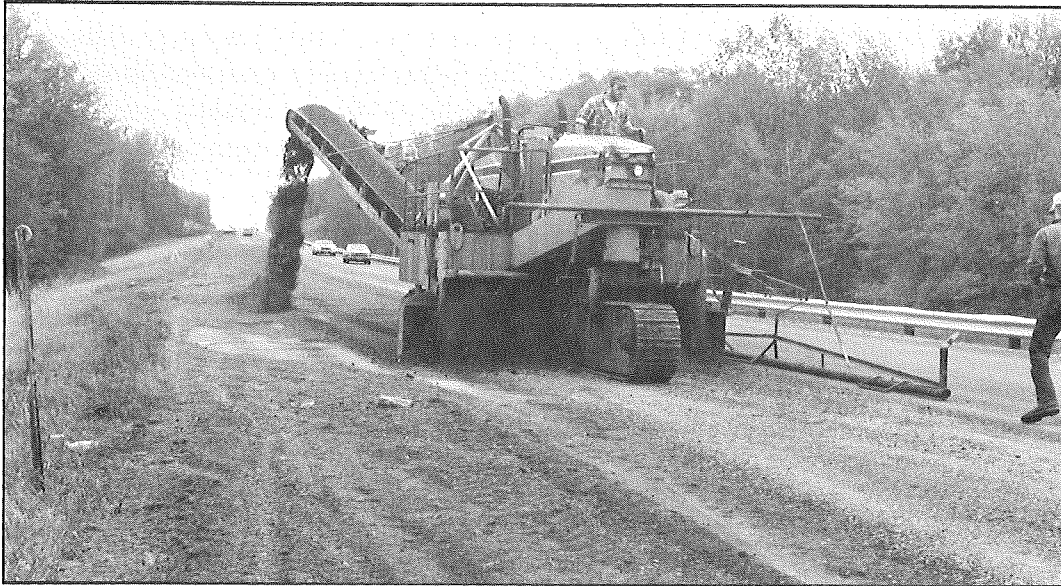


Figure 8. Trimming the compacted stabilized base to the desired cross-section with an autograder.

The major problems encountered were due to equipment malfunctions and limitations. This was especially true of the CMI Rotomill, because of its newness in the field of construction and the limited experience of its operators. The CMI was able to pulverize only the top 2-1/2 in. rather than the entire 4-1/2 in. of asphalt in one pass, as was hoped, without constant breakdowns. Therefore, it was necessary to use the hammermill and make a second pass in order to crush the existing pavement, which lengthened construction time. Another problem encountered was one of mechanical breakdowns involving the P and H stabilizing machines. Both of these stabilizers were in need of repair throughout the project requiring replacement of drive gears and chains. These mechanical problems affected the speed of the construction project but did not affect the overall procedures or the results.

A problem which did affect the construction procedure to some extent, was trimming of the compacted base to the desired cross-section. It was found that the provisions made to control the grade were not effective, and it was necessary for the operator to adjust the machine frequently. This left the base somewhat rough and caused a problem when the leveling course was applied. Other problems were encountered in selecting the proper amount of asphalt cement to add, the moisture content needed for a uniform mix, and the utilization of compaction equipment with respect to other operations. Such problems were solved as they became apparent during the construction operations, and were not a major cause of delay.

Fuel and Energy Savings

Recording of fuel consumption was to be a part of the evaluation of this recycling method. However, a recycling project of this magnitude, 11 miles of roadway 38 ft wide and 4-1/2 in. thick, was a new experience for the contractor and required considerable experimentation to achieve efficient usage of the different pulverization machines. Because of this experimentation it was felt that project records did not reflect a true estimate of fuel economy. As an indication of potential for material and energy conservation it was estimated, during the planning stages of this project, that 80,000 gallons of asphalt and 51,000 tons of aggregate would be saved as compared with a rehabilitation method involving a separation course to provide an equivalent structure.

Construction Evaluation and Recommendations

Post-construction evaluation of the stabilized base will continue for the next five years. Initial studies were conducted in the fall of 1977 and included; in-place density measurements, coring of samples to be used for stability testing, and Benkelman beam load testing.

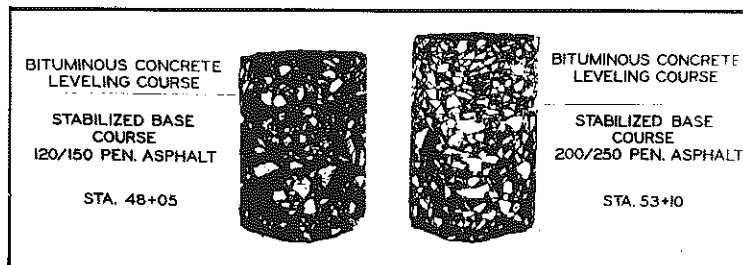


Figure 9. Typical cores obtained from recycled bituminous concrete pavement on I 75, Cheboygan County.

Special in-place density tests were conducted by Research Laboratory personnel, in addition to inspection testing during construction, to determine if the top 2-1/2 in. and the bottom 2-1/2 in. of the stabilized base layer were of the same density. Some cores, obtained immediately after construction, appeared to contain more voids in their lower portions than in the portion nearer the surface. In-place density tests were performed near these core locations and were made in a manner that would measure the density in the upper 2 to 3 in. and then in the lower layer. Several locations were tested but no consistent difference between top and bottom layers was found. Cores were obtained from the stabilized base from both the 200/250 sections and the 120/150 sections (Fig. 9). The cores obtained will be tested for structural strength as well as density and asphalt content.

Benkelman beam deflection measurements, using an 18-kip axle load, were made on the recycled pavement as a measure of its structural quality. For comparison purposes, deflection measurements were also made on adjacent sections of I 75 having two different cross-sections; 1) the opposite southbound roadway which was reconstructed using a 2-in. bituminous base separation course over the existing 4-1/2 in. bituminous concrete surface, as previously mentioned, and 2) the original pavement section immediately south of the recycling project. A comparison of the deflections obtained for the different base conditions are presented in Table 2. Future evaluation of this project will consist of deflection measurements, rut depth determinations, and crack surveys, on an annual basis.

TABLE 2
 BENKELMAN BEAM BITUMINOUS PAVEMENT
 DEFLECTION MEASUREMENTS ON I 75,
 CHEBOYGAN, OTSEGO, AND ROSCOMMON COUNTIES

Location	Deflection Measurement, in.	Pavement Temp., F	Date
Old pavement south of recycling project			
(northbound)	0.0134	45	10-27-77
(southbound)	0.0127	67	10-26-77
Separation course on SB I 75, Cheboygan Co.	0.0084	60	10-26-77
Recycled pavement, NB I 75, Cheboygan Co.			
(120/150 penetration)	0.0122	46	10-27-77
(200/250 penetration)	0.0123	63	10-25-77
Black base on NB I 75, Roscommon Co.	0.0134	52	11-20-72
Aggregate base on NB I 75, Roscommon Co.	0.0133	41	11-20-72

The reconstruction of the 11-mile portion of I 75 was successfully completed using mixed-in-place procedures to recycle the old bituminous concrete to form a new stable base layer. It was felt, however, that several improvements in construction procedures and controls should be initiated on similar projects in the future. In order to obtain suggestions and ideas from those involved in this project, a meeting was held in the Research Laboratory on September 16, 1977, which included personnel from the Department's Testing and Research and Construction Divisions, and the contractors. From this meeting, it was determined that there were three areas of mutual concern: 1) trimming of the recycled base, 2) traffic control during construction, and 3) mixing and compaction of the recycled base.

From this and subsequent meetings, and experience gained during this project, the following changes or additions have been recommended for inclusion in the specifications.

1) Asphalt cement penetration grade 200/250 should be added to the asphalts permitted for use.

2) The amount of bitumen to be added shall be between 0 and 3 percent by weight of the bituminous mixture.

3) Mixing temperature of asphalt cement shall be kept below the flash point but not less than 350 F.

4) Recycled material shall be uniformly pulverized such that 95 percent shall pass a 2-in. sieve.

5) All material which does not pass the 2-in. sieve shall not be large enough to adversely affect the stability, structural integrity, and shaping of the surface.

6) Material trimmed from the grade shall be used for grading shoulder edges as directed by the Engineer.

7) Moisture content of the pulverized material shall be adjusted by aeration or by adding water as directed by the Engineer prior to adding bituminous material.

8) The mixed material shall be rough graded to the established grade within a tolerance of $\pm 3/4$ in.

9) When asphalt cement is used, compaction and rough grading shall be accomplished as soon as possible after addition of the bituminous material.

10) Shaping shall be accomplished by use of a subgrade machine operating on crawler tracks or by other approved equipment. Such equipment shall be controlled by a traveling string line not less than 30 ft in length or with a preset string line as directed by the Engineer.

11) As directed by the Engineer, a self-propelled sheepfoot roller shall be used for initial compaction.

12) Traffic shall not be permitted on the stabilized base prior to resurfacing.

13) The density of the stabilized mixture shall be attained prior to final shaping.

It is felt that with these additions and changes in the specifications, the construction of future recycling projects can be improved. Also, it is hoped that future developments in equipment and technology will provide more efficient and economical methods for recycling older pavements.

REFERENCES

1. Copple, Fred, "Performance Evaluation of Mixed-In-Place Bituminous Stabilized Shoulder Gravel," Michigan Department of State Highways and Transportation, Research Report No. R-792, 1971.
2. "Proposal for a Research Study, Mixed-In-Place Stabilization of Soils with Bituminous Materials," Michigan Department of State Highways and Transportation, Research Project 72 F-125, 1972.
3. DeFoe, J. H., "In-Place Stabilization of Soil-Aggregate Mixtures with Bituminous Materials," Michigan Department of State Highways and Transportation, Research Report No. R-923, 1974.
4. DeFoe, J. H., "Mixed-In-Place Stabilization of Highway Base Aggregates and Pulverized Bituminous Surfacing Using Asphalt Stabilizers," Michigan Department of State Highways and Transportation, Research Report No. R-1051, 1977.
5. "AASHTO Interim Guide for Design of Pavement Structures, 1972," AASHTO, 1974.

APPENDIX

STANDARD SPECIFICATIONS FOR HIGHWAY CONSTRUCTION, MDSHT, July 1, 1976 (SECTION 3.04)

3.04 BITUMINOUS AGGREGATE BASE COURSE STABILIZED IN PLACE

3.04.01 Description.—This work shall consist of scarifying, pulverizing, crushing, adding new material, as required, and shaping to the plan grade for stabilizing with bituminous material, and shaping, rolling, and compacting the stabilized aggregate to the proper elevation and slope.

3.04.02 Materials.—The bituminous materials shall meet the requirements specified in Division 8, as follows:

Bituminous Materials 8.04
MC-800, SC-250, SC-500, SC-800A, MS-2h,
T-4, T-6, Asphalt Cement Penetration
Grade 120-150, 200-250

The bituminous material shall be applied at the rate as determined by the Engineer so that the residual bitumen added will be between 2 and 5 percent by weight of the bituminous mixture. Residual bitumen content shall be computed based on the residue of the bituminous material being applied.

When additional aggregate is required, it shall be 20A or 22A aggregate.

When the bituminous material to be used is not specified on the plans or in the proposal, the Contractor shall select one of the bituminous materials specified above.

3.04.03 Equipment Requirements:

a. **Rollers.**—Rollers shall meet the requirements as specified under Rollers, 4.12.03-f, except that combination pneumatic-steel wheel and vibratory rollers will be permitted.

b. **Crushing Equipment.**—When the use of crushing equipment is specified in the proposal, the equipment shall be an approved rotary reduction machine having positive depth control adjustments in increments of one-half inch and capable of reducing material which is at least six inches in thickness. The machine shall be of a type designed by the manufacturer specifically for reduction in size of pavement material, in place, and be capable of reducing the pavement material to the specified size. The cutting drums shall be enclosed and shall have a sprinkling system around the reduction chamber for pollution control. The rate of forward speed must be positively controlled in order to ensure consistent size of reduced material. The machine must be equipped with an accurate tachometer which is mounted in full view of the operator. The crushing equipment shall meet the approval of the Engineer.

c. **Mixers.**—Mixers shall be self-propelled and a combination scarifier, pulverizer, mixer, and liquid distributor. Unless otherwise specified, a minimum of 2 mixers will be required. The mixing rotor or rotors shall have a positive depth control to insure a uniform depth of mixing. The spray bar for distribution of the liquid shall operate in such a manner that all asphalt will be uniformly applied through the mixer at the time of mixing. The

equipment for distributing the bituminous material shall be adjustable and shall measure accurately the amounts of bituminous material being applied. The bitumen pump shall be a positive displacement type pump. It shall be equipped in such a manner as to make it possible to check accurately the rate of application of the bitumen at any time. The mixer shall meet the approval of the Engineer.

CONSTRUCTION METHODS

3.04.04 Scarifying and Pulverizing.—The material shall be scarified and uniformly pulverized to a maximum size of 2 inches and to the depth specified on the plans or in the proposal, by one or more passes. The maximum length or width of roadbed to be scarified and pulverized at any one time shall be as directed by the Engineer.

3.04.05 Grading.—Excess material not incorporated into the work will become the property of the Contractor and shall be disposed of as specified under Disposing of Surplus and Unsuitable Material, 2.08.07.

Additional aggregate shall be placed as necessary to attain the plan cross section.

After the material has been balanced, it shall be thoroughly mixed. In guard rail areas, on ramps, and in bridge areas, the material to be mixed may be bladed into a windrow to provide working room for the mixer. The grade shall be shaped to a uniform crown and grade.

3.04.06 Mixing with Bituminous Material.—The bituminous material shall be added only to that material which can be completely mixed, aerated, dried, and compacted in one day. The bituminous material shall be added through the mixer, at the rate and temperature directed by the Engineer. The aggregate-bituminous mixture shall then be bladed into a windrow and mixed with the mixer, the operation proceeding from one side of the work area to the other (approximately 4 to 8 windrow-mix coverages) until the mixture presents a uniform composition, free from fat spots and excess moisture, except that windrowing will not be required where asphalt cement is used nor for shoulder stabilization.

3.04.07 Aeration.—Aeration of the mixture shall continue until the mixture is dried to the moisture content approved by the Engineer, within the range of 2 to 5 percent, based on dry weight.

3.04.08 Shaping, Rolling, and Compacting.—Mixing, shaping, and compacting shall be done while the bituminous material is in a workable state. The mixed material shall be so shaped that when compacted it shall be in reasonably close conformity with the lines, grades, and cross sections shown on the plans or established by the Engineer. Initial rolling may be done with a pneumatic-tired roller or rollers. The aggregate-bituminous

mixture shall be compacted to not less than 98 percent of the unit weight obtained by the AASHTO T 180 test method. Such test shall be made on the aggregate-bituminous mixture at the field moisture content existing during the compacting operation. Required density shall be maintained until the material has been surfaced.

3.04.09 Curing.—The base may be opened to traffic for a period of time to be determined by the Engineer prior to placing of the surface. Any imperfections in the base course shall be repaired as directed by the Engineer.

3.04.10 Weather Limitations.—Bituminous material shall not be applied to the grade or to the aggregate when rain is threatening or when the air temperature is lower than 55 F.

The stabilization work shall be performed in the Lower Peninsula during the period June 1 to September 15, and in the Upper Peninsula during the period June 15 to September 1, unless otherwise authorized by the Engineer.

MEASUREMENT AND PAYMENT

3.04.11 Method of Measurement:

Bituminous Base Stabilization, to the depth specified, will be measured in square yards.

Bituminous Material—Base Stabilizing required for stabilization will be measured by volume in gallons of residual bitumen at a temperature of 60 F in accordance with the methods specified under Measurement of Quantities, 1.09.01.

When additional aggregate is required, the additional aggregate will be measured by weight in tons or in cubic yards, loose measure, as Aggregate—Base Stabilizing. The pay weight for aggregate used in road mix will be based on the scale weight of the material, provided the moisture content, determined at the time of weighing, does not exceed 6 percent. If the material contains more than 6 percent moisture, the excess over 6 percent will be deducted from the scale weight. No correction or additions will be made to the scale weight if the aggregate contains less than 6 percent moisture. The determination of moisture content and pay weights will be as specified under Measurement of Quantities, 1.09.01.

3.04.12 Basis of Payment.—The completed work as measured for BITUMINOUS AGGREGATE BASE COURSE STABILIZED IN PLACE will be paid for at the contract unit prices for the following contract items (pay items).

Pay Item	Pay Unit
Bituminous Base StabilizationSquare Yard
Bituminous Material—Base StabilizingGallon
Aggregate—Base StabilizingTon
Aggregate—Base Stabilizing (LM)Cubic Yard

SPECIAL PROVISIONS
FOR
BITUMINOUS AGGREGATE BASE COURSE STABILIZED IN PLACE

The following changes to Section 3.04 of the 1976 Standard Specifications shall apply to this project:

- 3.04.02 - Materials - The Bituminous Material shall be either MC 800 or Asphalt Cement penetration grade 120-150.

The bitumen added shall be between 0 and 5 percent by weight of the bituminous mixture. The minimum mixing temperature of Asphalt Cement shall be 330° Fahrenheit.

- 3.04.03 - Equipment Requirements - b. Crushing Equipment - A minimum of two crushers shall be required. In lieu of a rotary reduction machine, the Contractor may elect to transport the material to a crusher. As an alternate method, the existing material may be removed from the roadway, crushed to a size meeting this specification, processed through a mixing plant, and replaced on the roadway using a conventional mechanical paver in conformance with the provisions of Bituminous Base Course, Section 3.05.

c. Mixers - Add the following:

If asphalt cement is used one mixer shall be a self-propelled single pass stabilizer, combining a cutting rotor, a blending rotor, and at least one mixing rotor in the mixing chamber.

If a mixing plant is used, it shall conform to the provisions of Section 7.10.04 and meet the requirements for producing 3.05 Bituminous Base Course mixtures. The plant shall at all times conform to local and state air quality standards. The Engineer may require application of sufficient heat to the mixture in the plant to achieve adequate workability at no additional cost to the Department.

If MC 800 is used the Standard specifications shall apply.

- 3.04.08 - Shaping, Rolling, and Compacting - The mixed material shall be shaped to the established grade within a tolerance of $\pm 3/8$ inch and the following requirements shall apply: Final shaping shall be accomplished by use of a subgrade machine operating on crawler tracks, or by other approved equipment, that is controlled by a preset mechanical or electronic guide or by a manufacturer-approved ski-type attachment or traveling string line, not less than 30 feet in length.

If a mixing plant is used, the AASHTO T-180 Unit Weight shall be determined as the material is discharged from the plant. Placement of the plant mixed base material shall be done in accordance with Section 3.05.

3.04.09 - Curing - The Engineer may permit traffic on the stabilized base for periods not to exceed 48 hours prior to placing of the surface. Such traffic shall not be permitted if it causes ruts, potholes, or other disintegration. Rutting, potholes, or other areas of disintegration in the stabilized base shall be repaired with Bituminous Concrete Leveling Course as directed by the Engineer.

The provisions set forth in Section 1.08.05, Adequacy of Methods and Equipment, will apply to this Special Provision.

Basis of Payment

Repair of the stabilized base due to damage caused by public traffic will be paid for at the contract unit price for Bituminous Concrete Leveling Course.