EVALUATION OF SALVAGED BASE COURSE MATERIALS

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This study was conducted at the request of the Testing and Research Soils Section in regard to proposed construction of M 28, Control Section 02041, Job No. 00011A. The purpose of the investigation was to determine whether or not base course aggregate and bituminous surfacing could be salvaged from the existing roadway for re-use as aggregate base for shoulders and roadway on the proposed project.

Evaluation Procedure

Samples of the aggregate alone and aggregate mixed with existing bituminous surfacing were tested for maximum unit weight and optimum moisture content as well as for shear strength under triaxial loading. Marshall stability and flow values were also determined for the mixtures containing bituminous surfacing.

Mixtures tested consisted of aggregate alone and the aggregate mixed with pulverized bituminous surfacing in the ratio of 2 in. of surfacing to 6 in. of aggregate base.

Material Preparation

Gradation analysis was performed on each of 13 samples of materials (which consisted of aggregate mixed with bituminous surfacing when submitted) after the larger pieces of surfacing (+3/8-in.) were removed; results are shown in Table 1. These 13 samples were then combined into three composite laboratory samples of sufficient size to provide split portions for the unit weight, triaxial shear, and Marshall tests. One-half of each composite sample of aggregate was tested while the other half was combined with pulverized bituminous surfacing before testing. Sampling and combination schemes along with thickness of materials measured at the sampling sites are also included in Table 1.

Unit Weight Determinations

Moisture-density relationships were determined for these materials using the AASHTO T-180 method. The maximum unit weight thus established was used as the target density for preparation of triaxial shear test specimens. It was felt that the control of compactive effort provided by the automatic compactor used for the T-180 tests would provide more consistent results than would the Michigan Cone test. However, values were also obtained using both the Cone and the T-99 methods to provide a comparison of the methods. Results of these density-moisture tests are presented in Table 2.

Triaxial Shear Strength

Triaxial shear strength tests were performed on each of the three composite samples, both with and without bituminous surfacing included, giving

TABLE 1
GRADATION OF MATERIALS

Sample	Station	Aggregate Gradation, Percent Passing						Thickness, in.		Composite Sample No.
		1-in.	3/4-in.	3/8-in.	No. 4	No. 8	No. 40	Bit. Surface	Agg. Base	
1	560+00	100.0	97.2	75.2	53.3	39.1	16.4	1-1/2	10-1/2	74-38
2	565+00	97.9	92.3	74.4	53.0	39.2	18.6	1-1/2	8	
3	612+00	98.9	93.5	76.1	59.5	45.8	20.0	2	7	
4	617+00	98.4	95.6	76.8	58.4	45.0	20.3	2	5	
5	665+00	100.0	98.2	77.5	61.9	51.5	19.0	3	7	74-39
6	675+00	100.0	96.5	72.2	56.4	45.9	16.1	2	7-1/2	
7	725+00	100.0	100.0	83.1	66.7	56.1	21.8	1-1/4	9-3/4	
8	735+00	100.0	100.0	80.7	63.6	53.5	19.1	2	8-1/2	
9	755+00	100.0	98.0	77.1	60.9	50.1	20.7	2	8-1/2	74-40
10	763+00	100.0	99.0	79.6	64.8	55.6	24.1	1-1/2	8	
11	796+00	100.0	93.0	72.3	59.1	51.0	21.9	3	8	
12	802+00	100.0	97.0	76.5	61.2	51.2	24.6	2	6	
13	930+00	100.0	99.0	82.3	66.3	62.6	23.7	1-1/2	8-1/2	

a total of three pairs of individual samples for triaxial testing. The samples were prepared and tested at moisture contents about one percent below optimum with densities of individual samples ranging from 96.8 to 99.6 percent of maximum dry unit weight, as determined by the AASHTO T-180 method. Failure envelopes were determined for each of the three individual sample pairs. Results obtained for one of the pairs are shown in Figure 1 and are typical of results for the three sample pairs.

Tests similar to these have been performed in the Research Laboratory with dense graded aggregates and bituminous stabilized mixtures typical of materials incorporated in shoulder and base construction. Results of these tests, Table 3, provide a basis for comparing characteristics of these materials with those tested in this study. The shear strength of a 22A aggregate is also shown in Figure 1 along with results obtained from materials used in this study.

Stress conditions within the base, due to the design wheel load, are represented in Figure 1 by the Mohr circle, to allow direct comparison with failure envelopes for the test materials. Both materials have adequate shear resistance to support this load since their failure envelopes do not pass through the wheel load stress circle. The failure envelope for the 22A aggregate, however, is nearly tangent to the circle, a condition which would indicate incipient failure.

Marshall Stability and Flow Measurement

Samples containing bituminous surfacing were formed into Marshall specimens and tested for comparison with materials used in shoulder stabilization projects constructed this season. Comparative values for all projects are presented in Table 4. Criteria published by the Asphalt Institute [1] for hot plant-mixed base materials require the following values for medium traffic conditions:

Stability	500 lb, minimum
Flow	8 to 18, 1/100 in. units.

Heavy traffic conditions require a 750 lb minimum stability. All materials represented by Table 4 exceed the stability criteria and also meet the suggested flow requirements.

Conclusions and Recommendations

Triaxial shear strength and Marshall test results indicate that the salvaged aggregate base materials (either with or without the salvaged bituminous surfacing included) have sufficient strength and stability to be reused for base construction. It is recommended that the bituminous surfacing be pulverized to less than 1-1/2 in. in size prior to any significant mixing with the base aggregate. Scarifying, windrowing, and pulverizing with

[1] "The Asphalt Handbook," The Asphalt Institute, April 1965.

TABLE 2
MOISTURE DENSITY RELATIONSHIPS

Sample	T-180		Michigan Cone		T-99		Marshall
	Max. Den.	Moisture	Max. Den.	Moisture	Max. Den.	Moisture	γD
74-38	134.0	6.3					
74-38A*	133.5	5.5	132.0	6.3	131.9	6.3	126.95
74-39	134.8	5.6					
74-39A*	134.3	5.1	131.8	5.8	136.5	5.5	127.15
74-40	134.9	5.4					
74-40A*	135.3	5.0	134.2	6.3	135.1	5.9	127.83

* Sample consists of aggregate plus pulverized bituminous surfacing.

TABLE 3
TRIAXIAL SHEAR TEST RESULTS

	Sample	Friction Angle, Ø	Cohesion, C, psi	Material Description
M 28 Salvaged Material	74-38	46.6	6.0	Aggregate
	74-38A	41.5	5.7	Aggregate and Bituminous Surfacing
	74-39	42.5	7.0	Aggregate
	74-39A	44.5	5.3	Aggregate and Bituminous Surfacing
	74-40	46.2	6.3	Aggregate
	74-40A	41.0	8.0	Aggregate and Bituminous Surfacing
Aggregates	1	48.5	0	22A Aggregate, 7% P-200
	2	36.5	0	23A Aggregate, 15% P-200
	3	44.0	0	23A Aggregate, 7% P-200
	4	46.5	0	23A Aggregate, 7% P-200
	5	38.0	0	Uniformly Graded Sand
Stabilized Mixtures	6	42.4	7.5	22A Aggregate, 1.5% MC-800
	7	38.7	9.0	22A Aggregate, 2.0% MC-800
	8	51.4	0	22A Aggregate, 3.0% MC-800
	9	40.1	5.0	Granular Material, 2.0% MC-800
	10	43.4	4.0	Granular Material, 3.0% MC-800

a traveling hammer mill (such as a Bros Preparator) while working on the existing base is recommended. Base aggregate and pulverized surfacing would then be mixed sufficiently during their removal and storage.

The same compaction control procedures normally used for aggregate base course construction (either the Michigan Cone or the AASHTO T-180 method) should be used for this project. Nuclear gages, properly calibrated, also could be used on these materials with no compositional effects to be expected due to the asphalt present in the mixtures.

TABLE 4
TYPICAL MARSHALL TEST VALUES

Samples		Marshall Values	
		Stability, lb	Flow, 1/100 in.
M 28	74-38A	1,735	12.7
	74-39A	1,409	11.2
	74-40A	1,591	10.5
Shoulders	I 75	1,190*	12.7
	I 94	1,043*	8.2
	I 96	1,800*	7.5
	M 49	1,020*	15.8

*With residual asphalt and water contents as compacted on the job.

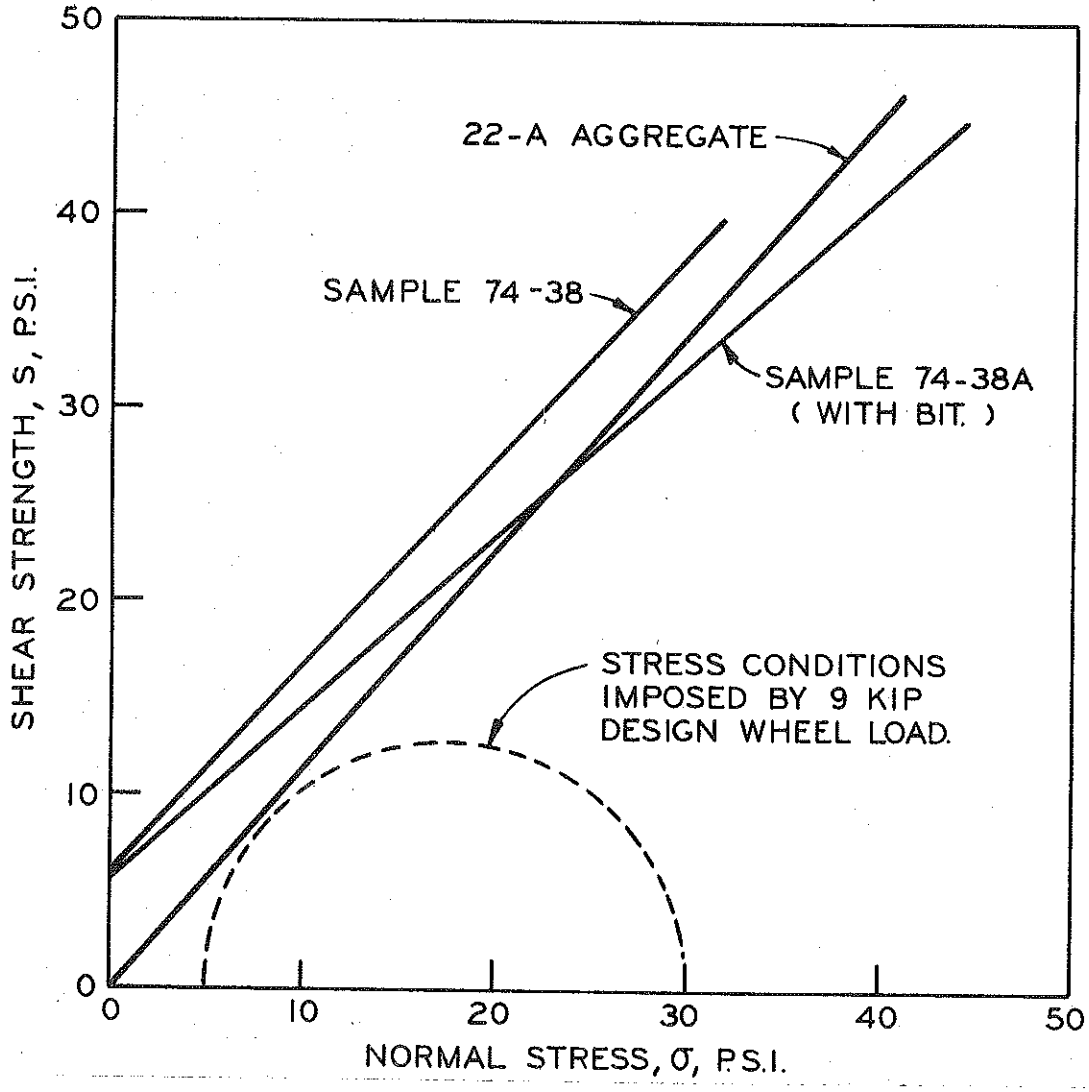

Figure 1. Shear strength of aggregate base and aggregate base with salvaged bituminous surfacing.