A REPORT ON THE LABORATORY EVALUATION OF CERTAIN SLURRY SEAL MIX DESIGNS FOR USE ON ODOT MAIN LINE PRIMARY HIGHWAYS

June 28, 1974

SUMMARY:

1. Middletown Slag, as sampled, is incompatible with quick set cationic system tested as well as with blends of cationic latex included in the emulsion system.

2. Middletown Slag can be used with quick-set cationic systems if it is properly blended with calcareous stone to neutralize an odd chemistry and smooth out variations in gradation.

3. Latex additions to cationic quick-set systems can be used effectively with slag-lime blends.

4. Xenia Gravel handles well with the addition of 1% portland cement in the cationic quick-set system.

5. Latex additions to the gravel system is entirely compatible and improves the adhesion of the mix with a corresponding reduction of asphalt required.

6. The 13.5% minimum acid insolubility of the gravel mixes along with field experience indicates that a long service life of the gravel slurry can be expected.

7. Further laboratory testing should be directed toward the actual job aggregate and emulsion selected for application.

Respectfully submitted,

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Included in this report is:

Summary
Objectives
Procedures
Observations
Traffic Counts
Materials
Trial Mix Summary
WTAT Test Summary
Bitucote Evaluation of Slag Mixes
ISSA Guide Spec 105 and WTAT Procedure T-100
Contractors Specification

OBJECTIVES:

On March 29, 1974 a group of Slurry Seal Contractors and material suppliers met with Mr. O. Carson Barklow, Director, Division of Operations, ODOT to discuss the potential use of slurry seal for the maintenance of selected main line primary highways. Those in attendance were:

Mr. Carson Barklow
Mr. Ron Zook
Mr. Darrell Montgomery, Slurry Seal of Columbus
Mr. John Perriott, Slurry Seal of Toledo
Mr. Jim Young, Young Asphalt Maintenance, North Lima
Mr. Al Cayton, Bitucote Products, Sharonville
Mr. Ray Terry, Slurry Seal of Southern Ohio, Hamilton
Mr. C. Robert Benedict, Benedict Slurry Seal, Dayton

Agreement was reached to carefully select a durable design and to apply to two sections of main line primaries of relatively low densities in the order of 4-5000VPD so that field studies and evaluation could be made. Because of previous poor performance of certain limestones it was agreed that slags and quality gravels and the use of rubber latexes should be studied in the design preparation.

Mr. Byron Niswender of the bureau of maintenance was charged with coordinating the design and preparation of plans and specifications with Mr. Dick Luce of the ODOT Laboratory.

On April 18, Mssrs. Niswender, Luce, Terry and Benedict met at the Broad Street Laboratory and discussed design procedures using the Wet Track Abrasion Test (WTAT), Method T-100 of the International Slurry Seal Association's guide specifications A-105 dated February 1972.

A new WTAT laboratory machine and supplies were furnished by the contractors along with aggregate, emulsion and latex samples. Preliminary work was performed in the laboratory with the assistance of Howard Voellinger and Steve Yanoshek on May 29, June 17,18,24,25,26.

PROCEDURES:

Some 26 trial mixes were made using the "Forswonic" 100 gram technique in 7 oz. plastic lined hot drink cups in order to determine mix, setting and drainage characteristics. From observation of the results of these trial mixes, a series of 700-gram mixes were made and subjected to Wet Track Testing. The results of both the trial mixes and Wet Track Mixes are attached.

The WTAT values are reported in grams/SF aggregate loss, after wet scrubbing the specimen with a weighted rubber hose for 5 minutes. Values in excess of 75 grams loss per square foot are considered unsatisfactory.

OBSERVATIONS:

The Xenia crushed gravel mixes all performed well. The Middletown slag was extremely sensitive to water variations, tended to "drain" and form greasy water barrier films of asphalt over the uncured mix which would likely present traffic problems in the field. The problem of drainage and gradation variation could be overcome by the use of blends with slag and gravel or limestone fines or by the use of large quantities of cement...perhaps 3 to 4%. The use of Latex emulsions in cationic systems with slag alone is definitely not recommended. Blends of slag with Agg. Lime or gravel seemed to neutralize some of the adverse chemistry of this slag and should not be ruled out. The investigation of quick set anionics or non-ionic emulsions may overcome this apparent incompatibility with cationics.

As indicated by the WTAT data, the inclusion of 3% latex emulsion in the asphalt emulsion system reduces the total amount of emulsion required by about 2% to achieve the same WTAT values. This observation could be applied to field practice as a margin of safety to assure no flushing in wheel tracts and overcome problems caused by field variations.

TRAFFIC COUNTS

My observations on durability indicates that traffic counts, wear rates and skid numbers are directly related to the acid insolubilty of the aggregate. The following tentative table from my limited experience may apply.

	Acid Insol.	Million Vehicles to "0" (2 lanes)	
8 Lb. Limestone	2%-	1.0	(25,000@35mph) (6 wks)
13Lb. "	2%-	4.3	(6,000@35mph) (2 yrs)
13Lb. "	2%-	6.7	(9,000@35mph) (2 yrs)
13Lb. Gravel	13%+	11.0+	(8,000@60mph) (4+yrs)

(SN_{40} at two yrs is 41)

From this very limited experience, I would expect a good 13 pound minimum slurry to last for 8,000 VPD, 2-lanes, through 15 million passes or about $5\frac{1}{2}$ years. By extrapolation, I would expect a good 18 pound slurry to effectively last through 20 million 2-lane passes or $5\frac{1}{2}$ years at 10,000 VPD.

More field observations will be necessary to correlate design, application and effective durability.

MATERIALS:

Asphalt Emulsion furnished by Bitucote, Lockland is CSS-1h or their "Blacat" is made from Shell 60/70 penn AC and contains 60.98% AC residue by evaporation.

Portland Cement is fresh and furnished by the laboratory.

Latex is Goodyear Cationic styrene emulsion of about 61% residual latex solids.

Aggregates:

I. American Aggregates, Xenia 100% crushed gravel
II. American Materials, Middletown air cooled slag
III. A 50/50 volumetric blend of I and II
IV. A 10% blend of II with American Aggs. Phillipsburg (Laurs) Agg. Lime

ISSA Type II gradation %passing		I-Xenia gravel	II-Midd Slag	III Blend Slag and Gravel
3/8"	100	100	100	100
4	90-100	99.4	99.2	99.3
6	---	90.9	94.6	92.7
8	65-90	74.4	78.3	76.6
16	45-70	49.6	48.4	49.2
30	30-50	34.4	29.5	32.5
50	18-30	24.7	18.9	22.6
100	10-21	17.9	12.8	16.5
200	5-15	11.7	8.9	11.9
Loose bulk weight by Fiock method		108.0 lbs. per CF	93.1 lbs. per CF	97.4 lbs. per CF
Acid insolubility discard- 200 decant		13.5%	46.0%	---

Note: The Middletown slag contained some unmixable agglomerated fines and ¼" oversize.

Note: The HCl acid insolubility of the slag on test produced a quantity of H_2S and also formed a stubborn gel with the sulfur and a portion of the aggregate residue.

TRIAL MIXES FOR MAIN LINE SLURRY - 5/29/74

SERIES:		AGGREGATE g.	PORTLAND CEMENT g.	WATER g.	ASPHALT EMULS. g.	ASPHALT EMULS. (3% 5% LATEX INCL.)	MIX TIME sec.	SET TIME	REMARKS.
101	①	100	0	10	18	—	20	BROKE - MUST HAVE CEMENT	
AMERICAN	② *	100	1/4	10	18	—	105	5+	- SL. DRY.
AGGS - XENIA	③	100	3	11	18	—	90	10±	- TOO DRY
GRAVEL	④	100	3	13	19	—	150	20±	- OK
5/29/74	⑤ *	100	1/2	13	20	—	210	—	TOO WET
	⑥ *	100	1/2	14	15	—	95	—	SL. DRY
102	① *	100	0	10	18	-	90	8	FAIR - SL. BALLING -
AMER. MTLS	②	100	1	12	18	—	120	—	SL. WET
MIDDLETOWN	③	100	3	13	18	-	110	—	GOOD - TOO WET
SLAG	④	100	2	13	15	-	90	—	GOOD
	⑤	100	1	9	20	-	105	—	GOOD
	⑥ *	100	1	15	12	-	90	—	GOOD
103									
MIDDLTN SLAG	①	100	1	16	12	—	110	—	SL. WET - TOO LEAN
XENIA GRAVEL	② *	100	1	13	15	—	140	—	SL. WET
50/50 Voi Blend	③	100	1	10	18	-	190	-	SL. WET
	④	100	1	9	21	-	210	-	SL. WET - TOO RICH
104									
MIDDLETOWN	① *	100	1	15	12	-	120	-	SL. WET
SLAG W/ LAURA	② *	100	1	12	15	-	85	-	GOOD
AGG LIME 10%	③ *	100	1	9	18	-	95	-	SL DRY - TACKY
	④	100	1	8	20	-	115	-	SL DRY - TOO RICH
105									
MIDD SLAG W/	①	100	1	13	3	12	140+	VERY SLO	RUBBER IMPROVES MIX & MIXTIME; TENDENCY TO "HAIROVER"
10% AGG, LIME	②	100	1	11	—	15	++	1hr+ SL DRY	
	③	100	1	9.5	—	18	++	1hr+ GOOD	
106									
MIDD SLAG	①	100	0	11	—	12	75	1hr+	SL. DRY - FOAMY
	②	100	1	12	—	12	90+	1hr+	SL. DRY - GOOD
	③	100	1	11	-	15	120+	1hr+	SL. DRY - GOOD

WET TRACK ABRASION TESTS OF SLAG-½" GRAVEL ASPHALT EMULSION SLURRY MIXES FOR C.D.O.T. DESIGN EVALUATION — 6/25/74 - C.R. BENEDICT

		AGG. %	P.C. %	WATER %	A.E. %	A.E. w/ 3% LATEX MOD.	WTAT g/SF	
101-2	XENIA GRAVEL	100	1	11	17	–	68	
101-5	" "	100	1½	12	20	–	7	FINES FLOATED - WET
101-6	" "	100	1½	14½	15	–	9	FINES FLOATED - WET
102-1	MIDDLETOWN SLAG	100	0	10	18	–	3	
102-6	" "	100	1	15	12	–	131	
104-2	MID. SLAG w/ 10% LAURA AGG. LIME	100	1	12	15	–	67 □	– TOUGHT, CREAMY
6/17-1	MID. SLAG	100	0	9	16	–	87*	TOO GREASY, SL. GR.
-2	" "	100	0	10	14	–	147*	SL. GREASY
-3	" "	100	0	9	–	16	62*	GREASY
-4	" "	100	1	9	16	–	83*	GREASY - SL. SCREEDY
-5	20/80 SLAG/GRAVEL	100	1	10	17	–	61 □	GOOD
-6	" "	100	1	10	–	17	55 □	SL. GREASY O.K.
6/18-1	MID. SLAG	100	1½	10½	14	–	258*◊	SPECIMENS NOT WELL DRIED OR CURED
-1a	" "	100	1½	10½	–	14	153*◊	LOOKS FAIR
-2	" "	100	3	11	14	–	128*◊	
-2a	" "	100	3	11		14	103*◊	LOOKS FAIR
6/24-1	XENIA GRAVEL	100	1	11	16	–	37 □	SL. BROKEN GOOD
-2	" "	100	1	8	18	–	20 □	V. SL. BROKEN GOOD
-3	" "	100	1	11	—	16	20 □	GOOD - SL. RICH
-4	" "	100	1	8	–	18	12 □	GOOD - SL. RICH

NOTES: – WEIGHT WAS 4.75# – S/B 5.00#, VALUES ARE SLIGHTLY LOW.
□ RECOMMENDED. – REPRODUCIBLE.
* EXTRAPOLATED FROM 3 MINUTES
◊ SPECIMENS MAY NOT HAVE BEEN DRIED INITIALLY.

Bitucote PRODUCTS CO.

MARKETERS & MANUFACTURERS

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EMULSIFIED ASPHALT PRODUCTS

March 26, 1974

Mr. Ray Terry
Slurry Seal of Southern Ohio
4449 Princeton Pike
Hamilton, Ohio

Dear Ray:

Following are the test results of slag sample submitted in December 1973. Received in lab. 12/7/73, Tested 12/10/73, Lab mo~~ker~~ TS287.21. Identification: Aggregate for slurry seal: Source: American Materials Material Classification SLAG. Moisture as received 2.85%. Unit weight of dry aggregate 101.6 lb/eu/ft.

SIEVE SIZE	PASSING	TYPE II SLURRY
1/2	100%	100%
3/8	100%	100%
4	96.6%	90-100%
8	75.7%	65-90%
16	45.6%	45-70%
30	26.0%	30-50%
50	15.2%	18-30%
100	9.1%	10-21%
200	4.8%	5-15%

As you can see from the gradation of the above sample, this is not a uniform gradation. This type of a gradation is hard to work with with any type of aggregrate, but it is especially true with slags. The amount of moisture added to most slag and emulsion mixtures, especially one with a deficiency in the amount passing #30, #50, #100, and #200 is more critical than any other type aggregate with the exception of certain silicas. Please note this from the following tests run on this aggregate.

All percentages based on dry aggregates.

	WATER	AE	CEMENT	CONSISTANCY	SEGREGATION
A	15	18	2	Good	Poor
B	10	18	3	Good	Good
C	15	18	3	Good	Poor
D	12	15	3	Good	Good
E	8	20	3	Good	Good

The emulsion used had a residue asphalt content of 62%. On this basis it becomes evident that sample:

A had a total of 21.84% moisture
B had a total of 16.84% moisture
C had a total of 21.84% moisture
D had a total of 17.7% moisture
E had a total of 15.6% moisture

It was found that mixes A and C, as they cured, segregated badly even though sample C had an extra percentage of cement added in an attempt to off set the lack of fines. It was apparent upon examination of sample B that the right moisture, asphalt, and slag relationship had been established for this gradation of this type of slag.

Samples D and E were run to further check out chemical set of mixture, total mixing time on either side of sample B. It was found that sample E would have been ready for traffic quickest and was a better wearing surface.

On the 29th of January 1974 more samples were received at St. Louis identified as American Materials slag. These fines identified as: TS-45.23 Course slag and TS-44.23 Slag ~~fines~~.

GRADATIONS

	TO-44.23	ISS Type II	TS-45.23
1/2	100%	100%	100%
3/8	100%	100%	100%
4	99.3%	90-100%	99.3%
8	98.8%	65-90 %	80.1%
16	97.8%	45-70 %	55.2%
30	88.0%	30-50 %	28.5%
50	72.6%	18-30 %	13.3%
100	48.3%	10-21 %	5.2%
200	26.1%	5-15 %	2.2%

As we had been asked to make recommendations for blends of the above two gradations and further asked to keep these blends simple the following blends were made on weight basis.

Blend #1

3 parts TS-45:23 slag aggrate
1 part TS-44:23 slag fines

Blend #2

2 parts TS-45:23 slag aggrate
1 part TS-44:23 slag fines

Gradations

	Blend #1	Issa Type II	Blend #2
1/2	100%	100%	100%
3/8	100%	100%	100%
4	99.3%	90-100%	98.8%
8	85.0%	65-90%	84.5%
16	65.9%	45-70%	66.6%
30	43.4%	30-50%	47.1%
50	28.1%	18-30%	32.7%
100	16.0%	10-21%	19.6%
200	8.1%	5-15%	9.9%

Though blend 2 shows the #50 as being slightly higher, this blend showed less susceptibility to changes in moisture from the asphalt emulsion and mix water.

SUMMARY:

From experience a properly graded slag aggregate (either air cooled or water quenched) can be used to produce good slurry seals. All slag aggrates should be checked with the asphalt emulsion to be used for the project, this primilary due to chemical make up of slags from different processes.

All slag aggregates used in slurry seal applications should be crushed well in advance of job start. These stock piles also must be protected from rain and wind, as most slag unit weights are lighter than crushed gravels and limestone. Therefore, the fines tend to separate faster than heavier aggregates.

Sincerely yours,

BITUCOTE PRODUCTS CO.

Estell L. Johnson
Technical Sales Representative

ELJ/myb

INTERNATIONAL SLURRY SEAL ASSN.

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GUIDE SPECIFICATIONS A-105
DATE: FEBRUARY, 1972
Replaces Associations Specifications
A-101, A-102, A-103 and A-104

1. SCOPE

The work covered by this specification consists of furnishing all plant, labor, equipment, and materials in performing all operations necessary in connection with the application of an emulsified asphalt slurry seal surface upon the designated surface, in complete and strict accordance with the specification.

2. APPLICABLE SPECIFICATIONS

The following specifications and methods form a part of this specification: (alternates are listed for most specifications and methods; one should be selected which is most applicable)

AASHO—American Association of State Highway Officials

ASTM—American Society For Testing and Materials

ISSA—International Slurry Seal Association

AGGREGATE AND MINERAL FILLER

Alternate 1	Alternate 2	
AASHO T2	ASTM D75	Sampling Stone, Slag, Gravel, Sand and Stone Block for use as Highway Materials
AASHO T27	ASTM C386	Sieve Analysis of Fine or Coarse Aggregate
AASHO T11	ASTM C117	Amount of Material Finer than No. 200 Sieve in Aggregate
AASHO T176	ASTM D2419	Plastic Fines in Graded Aggregate and Soils by use of the Sand Equivalent Test
AASHO T84	ASTM C128	Specific Gravity and Absorption of Fine Aggregate
AASHO T19	ASTM C29	Unit Weight of Aggregate
AASHO T96	ASTM C131	Abrasion of Coarse Aggregate by use of the Los Angeles Machine
AASHO T127	ASTM C183	Sampling Hydraulic Cement
AASHO T37	ASTM D546	Sieve Analysis of Mineral Filler
	ASTM D242	Mineral Filler for Bituminous Paving Mixtures

EMULSIFIED ASPHALT

AASHO T40	ASTM D140	Sampling Bituminous Materials
AASHO T59	ASTM D244	Testing Emulsified Asphalt
AASHO M140	ASTM D977	Specifications for Anionic Emulsified Asphalt
AASHO M208	ASTM D2397	Specifications for Cationic Emulsified Asphalt
Emulsion Manufacturer		Specifications for "Quick-Set" Emulsified Asphalts for Slurry Seals
AASHO T164	ASTM D2172	Bitumen Content of Paving Mixture by Centrifuge
AASHO T30		Mechanical Analysis of Extracted Aggregate
	ISSA T100	Measurement of Wear of Slurry Seal Mixtures by Wet Track Abrasion

3. DESCRIPTION

The slurry seal surface shall consist of a mixture of emulsified asphalt, mineral aggregate, and water; properly proportioned, mixed, and spread evenly on the surface as specified herein and as directed by the Engineer (or Contracting Officer). The cured slurry shall have a homogenous appearance, fill all cracks, adhere firmly to the surface and have skid resistant texture.

4. MATERIALS

A. Asphalt Emulsion. The emulsified asphalt shall conform to the requirement of.....Specification, for type.....emulsion.

B. Aggregate. The mineral aggregate shall consist of natural or manufactured sand, slag, crusher fines, and others, or a combination thereof. Smooth-textured sand of less than 1.25 percent water absorption shall not exceed 50 percent of the total combined aggregate. The aggregate shall be clean and free from vegetable matter and other deleterious substances. When tested by AASHO T176 or ASTM D2419, the aggregate blend shall have a sand equivalent of not less than _____ (minimum 45 recommended). When tested according to _____ (AASHO T104 or ASTM C88) the aggregate shall show a loss of not more than _____ (e.g. 10%, 15%). When tested according to _____ (AASHO T-96 or ASTM C131) the aggregate shall show a loss of not more than _____ (e.g., 30%, 35%).

Mineral fillers such as portland cement, limestone dust, fly ash, and others shall be considered as part of the blended aggregate and shall be used in minimum required amounts They shall meet the gradation requirements of ASTM D242. Mineral fillers shall only be used if needed to improve the workability of the mix or gradation of the aggregate.

The combined mineral aggregate shall conform to the following gradation when tested by the previously mentioned test (select one)

Sieve Size	Type I Percent Passing	Type II Percent Passing	Type III Percent Passing
⅜	100	100	100
No. 4	100	90-100	70-90
No. 8	90-100	65-90	45-70
No. 16	65-90	45-70	28-50
No. 30	40-60	30-50	19-34
No. 50	25-42	18-30	12-25
No. 100	15-30	10-21	7-18
No. 200	10-20	5-15	5-15
Theoretical Asphalt Content % Dry Aggregate	10-16	7.5-13.5	6.5-12

Type I. This aggregate blend is used to seal cracks, fill voids, and correct moderate surface conditions. An approximate application rate of 6 to 10 pounds per square yard based on dry aggregate weight is used when standard aggregates are utilized. The fineness of this design provides it with maximum crack penetrating properties. A typical example of this type of slurry surface would be on airfields or other areas where only protection from the elements is desired.

Type II. This aggregate blend is used when it is desired to fill surface voids, correct severe surface conditions, and provide sealing and a minimum wearing surface. An approximate application rate of 10 to 15 pounds per square yard based on dry aggregate weight is used when standard aggregates are utilized. A typical example of this type of slurry surface would be on pavements with medium textured surfaces which would require this size of aggregate to fill in the cracks and provide a minimum wearing surface. Another example would be placing a general slurry on flexible base, stabilized base, or soil cement as a sealer prior to final paving.

Type III. The aggregate blend is used to give crown correction and a moderate wearing surface. It is applied at a rate of 15 pounds per square yard, or more, based on dry aggregate weight for normal aggregate. A typical example of this type of slurry surface is the first and/or second course of a two-course slurry

treatment on flexible base, stabilized base, or soil cement. Another example of this type of slurry surface would be on pavements which have highly textured surfaces and require this size of aggregate to fill in the voids and provide a moderate wearing surface.

C. Water. All water used with the slurry mixture shall be potable and free from harmful soluble salts.

D. Laboratory Testing. Sources of all materials shall be selected prior to the time the materials are required for use in the work. All samples shall be taken according to procedures previously mentioned. All materials shall be pretested in a qualified laboratory as to their suitability for use in slurry. The theoretical asphalt content shall be determined. The laboratory shall also determine if a mineral filler is required, and if so, how much should be used. Test samples shall be made and tested on a Wet Track Abrasion Machine.

A complete laboratory analysis and test report accompanied by abraded and unabraded slurry test samples shall be submitted by the contractor before the job starts. (The ISSA can furnish a list of qualified testing laboratories.)

E. Stockpiling of Aggregate. Precautions shall be taken to insure that stockpiles do not become contaminated with oversized rock, clay, silt, or excessive amounts of moisture. The stockpile shall be kept in areas that drain readily. Segregation of the aggregate will not be permitted.

F. Storage. The Contractor shall provide suitable storage facilities for the asphalt emulsion. The container shall be equipped to prevent water from entering the emulsion. Suitable heat shall be provided if necessary to prevent freezing.

G. Sampling. Samples of materials and of the finished slurry surface shall be furnished by the Contractor as directed by the Engineer (or Contracting Officer) during progress of the work. Test reports may be requested from the Contractor as additional materials arrive.

5. EQUIPMENT

All equipment, tools, and machines used in the performance of this work shall be maintained in satisfactory working order at all times. Descriptive information on the slurry mixing and applying equipment to be used shall be submitted for approval not less than _____ days before the work starts.

A. Slurry Mixing Equpment. The slurry mixing machine shall be a continuous flow mixing unit and be capable of delivering accurately a predetermined proportion of aggregate, water and asphalt emulsion to the mixing chamber and to discharge the thoroughly mixed product on a continuous basis. The aggregate shall be prewetted immediately prior to mixing with the emulsion. The mixing unit of the mixing chamber shall be capable of thoroughly blending all ingredients together. No violent mixing shall be permitted.

The mixing machine shall be equipped with an approved fines feeder that provides an accurate metering device or method to introduce a predetermined proportion of mineral filler into the mixer at the same time and location that the aggregate is fed. The fines feeder shall be used whenever added mineral filler is a part of the aggregate blend.

The mixing machine shall be equipped with a water pressure system and fog type spray bar adequate for complete fogging the surface preceding spreading equipment.

B. Slurry Spreading Equipment. Attached to the mixer machine shall be a mechanical type squeegee distributor equipped with flexible material in contact with the surface to prevent loss of slurry from the distributor. It shall be maintained so as to prevent loss of slurry on varying grades and crown by adjustments to assure uniform spread. There shall be a steering device and a flexible strike-off. The spreader box shall have an adjustable width. The box shall be kept clean, and build-up of asphalt and aggregate on the box shall not be permitted. The use of burlap drags or other drags shall be approved by the Engineer.

C. Cleaning Equipment. Power brooms, power blowers, air compressors, water flushing equipment, and hand brooms shall be suitable for cleaning the surface and cracks of the old surface.

D. Auxiliary Equipment. Hand squeegees, shovels, and other equipment shall be provided as necessary to perform work.

6. PREPARATION OF SURFACE

Immediately prior to applying the slurry, the surface shall be cleaned of all loose material, silt spots, vegetation, and other objectionable material. Any standard cleaning method used to clean pavements will be acceptable, except water flushing will not be permitted in areas where considerable cracks are present in the pavement surface. The Engineer (or Contracting Officer) shall give final approval of the surface.

If the slurry is being placed over a brick or concrete surface, highly absorbent asphalt surface, or over a surface where the aggregate has become exposed and is polished and slick, a 1 part emulsion, 3 part water, tack coat of the same asphalt emulsion type and grade as specified for the slurry is recommended. This can be applied with an asphalt distributor or suitable water truck. The normal application rate is 0.05 to 0.10 gallons of the diluted emulsion per square yard of surface. The Engineer (or Contracting Officer) should give final approval.

7. COMPOSITION AND RATE OF APPLICATION OF THE SLURRY MIX

The amount of asphalt emulsion to be blended with the aggregate shall be that as determined by the laboratory report after final adjustment in the field. A minimum amount of water shall be added as necessary to obtain a fluid and homogeneous mixture. The rate of application shall be (a minimum of _____ pounds of dry aggregate per square yard; at least _____ lbs./sy but not greater than _____ lbs./sy). The Engineer (or Contracting Officer) shall give final approval to the design and rate of application used.

8. WEATHER LIMITATIONS

The slurry seal surface shall not be applied if either the pavement or air temperature is 55° F or below and falling, but may be applied when both the air and pavement temperature is 45° F or above and rising. The mixture should not be applied if high relative humidity prolongs the curing beyond a reasonable time.

9. TRAFFIC CONTROL

Suitable methods such as barricades, flagmen, pilot cars, etc., shall be used to protect the uncured slurry surface from all types of traffic. Any damage to the uncured slurry will be the responsibility of the Contractor. The Engineer (or Contracting Officer) shall give final approval as to the method used. If damage occurs where suitable means have been made to protect the uncured slurry, violators will be prosecuted and the Contractor will be reimbursed for the amount of the damages.

10. APPLICATION OF THE SLURRY SURFACES

A. General. The surface may be prewetted by fogging ahead of the slurry box if required by local conditions. Water used in prewetting the surface shall be applied at such a rate that the entire surface is damp with no apparent flowing water in front of the slurry box. The slurry mixture shall be of the desired consistency when deposited on the surface and no additional elements shall be added. Total time of mixing shall not exceed four minutes. A sufficient amount of slurry shall be carried in all parts of the spreader at all times so that complete coverage is obtained. No lumping, balling or unmixed aggregate shall be permitted. No segregation of the emulsion and aggregate fines from the coarse aggregate will be permitted. If the coarse aggregate settles to the bottom of the mix, the slurry will be removed from the pavement. No excessive breaking of the emulsion will be allowed in the spreader box. No streaks such as caused by oversized aggregate will be left in the finished pavement.

B. Joints. No excessive build-up nor unsightly appearance shall be permitted on longitudinal or transverse joints.

C. Hand Work. Approved squeegees shall be used to spread slurry in non-accessable areas to the slurry mixer. Care shall be exercised in leaving no unsightly appearance from hand work.

D. Curing. Treated areas will be allowed to cure until such time as the Engineer (or Contracting Officer) permits their opening to traffic.

Rolling is normally not required on slurry surfaces. However, in areas of slow turning traffic, e.g., airfields, the paved suface should be rolled by a 5-ton roller. The paved area should be subjected to a minimum of five coverages. If a pneumatic roller is used it should be operated at a tire pressure of 50 pounds per square inch.

11. MEASUREMENT AND PAYMENT

Alternate specifications are listed; select one applicable to your operation.

ALTERNATE NO. 1

The slurry seal surface shall be measured and paid for by the weight of aggregate and volume of asphalt emulsion used on the work completed and accepted as designated by the Engineer (or Contracting Officer).

ALTERNATE NO. 2

The slurry seal surface shall be measured and paid for by the square yards of work completed and accepted as designated by the Engineer (or Contracting Officer).

TEST FOR WET TRACK ABRASION OF SLURRY SEALS
D-

1. Scope

1.1 This method of test covers measurement of the wearing qualities of slurry seal and other thin, fine aggregate bituminous surfacings under wet abrasion conditions.

2. Summary of Method

2.1 A slurry mixture of fine graded aggregate, asphalt emulsion and water is prepared at flowing consistency. The slurry is formed into a disc by pouring in the circular opening of a Lucite template resting on a larger circlet of heavy smooth roofing felt.

2.2 After removal of the Lucite mask the disc specimen is dried to constant weight at 140°F (60°C). The cured slurry is placed in a water bath for one hour, then mechanically abraded under water with a rubber hose for 5 minutes. The abraded specimen is washed free of debris, dried at 140°F (60°C) and weighed. The loss in weight expressed as grams per square foot (square metre) is reported as the Wear Value (WTAT loss).

3. Significance

3.1 The Wet Track Abrasion Test is a simulated performance test which can be correlated with the wearing qualities of slurry seals in the field.

4. Apparatus

4.1 Scale, capable of weighing 5,000 grams to within ± 1.0 grams.

4.2 Planetary type mechanical stirrer (such as the Hobart C-100 made by Hobart Mfg. Co., Troy, Ohio) equipped with a 5-pound weighted rubber hose holding device (abrasion head) with about one-half inch (0.0127 metre) free up-and-down movement in the shaft sleeve (Figure A-6).

4.3 Heavy (1/8") flat bottom metal pan, approximately 13" (0.330 metre) diameter with 2" (0.051 metre) vertical side walls (20° Ga or heavier) having 4 equi-spaced screw clamps capable of securing 11-1/4" (0.285 metre) diameter specimen to bottom of pan (Figure A-5).

4.4 Suitable heavy gauge round bottom bowl (such as type obtainable with Hobart C-100) to contain the sample during mixing.

4.5 Long-handled serving spoon of sufficient length to project 4" (0.101 metre) or more out of the round bottom bowl during stirring.

4.6 Supply of 11¼" (0.286 metre) diameter discs cut from smooth 50-60 pound (22.68-27.22 kilo) roofing felt.

4.7 Equipment used in specimen preparation such as a special circular Lucite template ½" (0.0063 metre) thick with an 11" (0.2794 metre) diameter circular opening (Figure A-2) and a 12"-14" (0.305-0.355 metre) short handled window squeegee.

4.8 Forced draft constant temperature oven thermostatically controlled at 140° ± 5°F (60° ± 3°C) see ASTM E 145 Type II B.

4.9 Constant temperature water bath controlled at 77°F ± 2°F (25° ± 1°C).

4.10 Reinforced rubber hose equivalent to U.S. Rubber Company P-290 (see Page 3 of Uniroyal - U.S. Rubber Cat. No. 330, dated 1966) with a 3/4" (0.019 metre) inside diameter and about ¼" (0.006 metre) wall thickness. This hose shall have a natural rubber/Buna S core (ASTM Designation "R") and a Neoprene cover (ASTM Designation "SC"). The hose shall be cut into 5" (0.127 metre) lengths and drilled with two paired 3/8" (0.009 metre) holes aligned on 4" (0.102 metre) centers. Avoid drilling holes on convex or concave side of hose.

4.11 Wooden Prop Block for supporting Hobart platform assembly into position during testing (See Figure A-3).

5. Procedure for Preparation of Test Specimen

5.1 The proper ratio of Portland Cement (or hydrated lime), water and asphalt emulsion to the dry weight of the aggregate shall be predetermined by the Consistency Test (See Slurry Seal Specification - Section 6.4) or a functional field mix design previously accepted by project engineer.

5.2 Quarter a sufficient amount of the air-dried aggregate passing No. 4 sieve to obtain at least 800 grams in one quarter.

5.3 Weigh 800 grams of aggregate into mixing bowl. Using the spoon dry mix the Portland Cement (or hydrated lime) into the aggregate for one minute or until uniformly distributed. Add the predetermined amount of water and mix again for one minute or until all aggregate particles are uniformly wetted. Finally add the predetermined amount of emulsion and mix for a period of not less than one minute and not more than three minutes.

5.4 Place the opening in the Lucite template over the $11\frac{1}{4}$" (0.2857 Metre) diameter disc of roofing felt. Immediately pour the slurry onto the felt (See Figure A-1).

5.5 Squeegee the slurry level with the top of the mask with a minimum of manipulation (excessive squeegeeing contributes to segregation). Scrape off excess material and discard.

5.6 Remove the Lucite mask - place the molded specimen in the 140°F (60°C) oven and dry to constant weight (minimum 24 hours drying time).

6. Wet Track Abrasion Test

6.1 Remove the dried specimen from the 140°F (60°C) oven - allow it to cool to room temperature and weigh.

6.2 After weighing, place the specimen in the 77°F (25°C) water bath for 60 to 75 minutes.

6.3 Remove the specimen from the water bath and place in the 13" (0.330 metre) diameter flat bottom pan. Secure the specimen to the pan bottom by tightening the four wing-nut washers.

6.4 Completely cover the specimen with at least $\frac{1}{4}$" (0.006 metre) depth of distilled water (temperature 77°F (25°C).

6.5 Secure the pan containing the specimen on the platform of the Hobart C-100 machine (Figure A-6). Lock the rubber hose abrasion head on the shaft of the Hobart machine. Elevate the platform of the Hobart machine until the rubber hose bears on the surface of the specimen. Use the prop block to support the platform assembly during testing (Figure A-6).

6.6 Switch to the low speed of the Hobart machine (144 shaft r.p.m. at 61 turns of the planetary). Operate the machine for exactly 5 minutes ± 2 seconds running time. A suitable timer such as GraLab Universal Timer, Model 167 may be used. Note: Install a fresh section of hose after completion of each test. It is permissible to rotate the hose 1/2 turn after each test run and obtain a fresh section for the next specimen.

6.7 Remove the specimen from the pan after the abrasion cycle and wash off debris. Place the washed test specimen in the 140°F (60°C) oven and dry to constant weight.

6.8 The dried specimen is removed from the 140°F (60°C) oven, allowed to reach room temperature and weighed. The difference between this weight and the weight obtained in Section 6.1 (Part II) is multiplied by 3.06 to express the loss in grams per square foot (wear value). Note: The factor 3.06 is used to convert the loss for the actual abraded area, 0.327 square feet, to a one-square foot basis. (The 3.06 value only applies to the Hobart C-100 machine with a 5" rubber hose.)

7. Report

7.1 The average wear value (WTAT loss) in grams per square foot (or grams per square metre) for each quantity of emulsified asphalt.