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Work done in cooperation with the Federal Highway Administration, Region 15. This is FHWA Experimental Project TX77-02.

16. Abstract

On June 1, 1978, an experimental road surface was designed and constructed in the State Department of Highways and Public Transportation District 8 near Abilene, Texas, to provide roadway skid resistance while conserving scarce skid resistant aggregates. The process, called "sprinkle treatment", has been used successfully in European contries for many years. The procedure calls for precoated aggregate to be placed on the surface of a hot-mix asphaltic concrete pavement prior to rolling. Hot and cold (ambient temperature) aggregate placements were attempted, skid testing and visual ratings were performed.

17. Key Words	18. Distribution Statement
sprinkle treatment aggregate embedment aggregate rolling aggregate dispersal	

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Sprinkle Treatment Placement

IH 20, Roscoe, Texas

Research Report 531-1

by
Jon P. Underwood

Texas Department of Highways and Public Transportation

Demonstration Project 1-10-77-531
"An Evaluation of Sprinkle Treatment Placement Procedures"

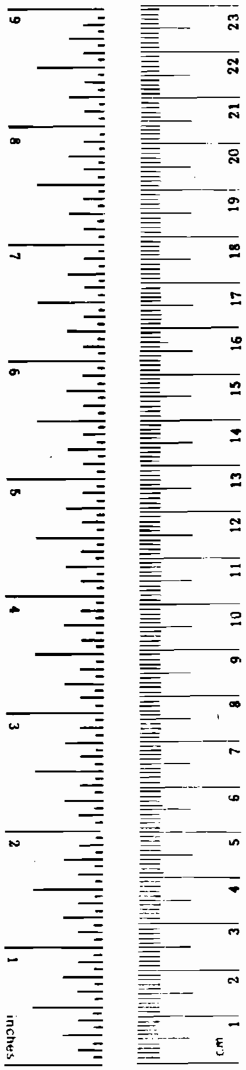
FHWA Experimental Project TX-7702

April, 1980

METRIC CONVERSION FACTORS

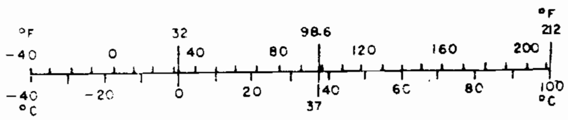
Approximate Conversions to Metric Measures

Symbol	When You Know	Multiply by	To Find	Symbol
		LENGTH		
in	inches	*2.5	centimeters	cm
ft	feet	30	centimeters	cm
yd	yards	0.9	meters	m
mi	miles	1.6	kilometers	km
		AREA		
in^2	square inches	6.5	square centimeters	cm^2
ft^2	square feet	0.09	square meters	m^2
yd^2	square yards	0.8	square meters	m^2
mi^2	square miles	2.6	square kilometers	km^2
	acres	0.4	hectares	ha
		MASS (weight)		
oz	ounces	28	grams	g
lb	pounds	0.45	kilograms	kg
	short tons (2000 lb)	0.9	tonnes	t
		VOLUME		
tsp	teaspoons	5	milliliters	ml
Tbsp	tablespoons	15	milliliters	ml
fl oz	fluid ounces	30	milliliters	ml
c	cups	0.24	liters	l
pt	pints	0.47	liters	l
qt	quarts	0.95	liters	l
gal	gallons	3.8	liters	l
ft^3	cubic feet	0.03	cubic meters	m^3
yd^3	cubic yards	0.76	cubic meters	m^3
		TEMPERATURE (exact)		
°F	Fahrenheit temperature	5/9 (after subtracting 32)	Celsius temperature	°C



Approximate Conversions from Metric Measures

Symbol	When You Know	Multiply by	To Find	Symbol
		LENGTH		
mm	millimeters	0.04	inches	in
cm	centimeters	0.4	inches	in
m	meters	3.3	feet	ft
m	meters	1.1	yards	yd
km	kilometers	0.6	miles	mi
		AREA		
cm^2	square centimeters	0.16	square inches	in^2
m^2	square meters	1.2	square yards	yd^2
km^2	square kilometers	0.4	square miles	mi^2
ha	hectares (10,000 m^2)	2.5	acres	
		MASS (weight)		
g	grams	0.035	ounces	oz
kg	kilograms	2.2	pounds	lb
t	tonnes (1000 kg)	1.1	short tons	
		VOLUME		
ml	milliliters	0.03	fluid ounces	fl oz
l	liters	2.1	pints	pt
l	liters	1.06	quarts	qt
l	liters	0.26	gallons	gal
m^3	cubic meters	35	cubic feet	ft^3
m^3	cubic meters	1.3	cubic yards	yd^3
		TEMPERATURE (exact)		
°C	Celsius temperature	9/5 (then add 32)	Fahrenheit temperature	°F



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INTRODUCTION

A major concern of all people involved in the various phases of transportation has been the alarming increase in wet pavement accidents. These accidents have caused the loss of many lives, millions of dollars in medical care, and billions of dollars in property damage.

This type of accident has been, for years, a basis for the expenditure of many dollars, primarily on research to determine the most effective pavement surface to reduce the alarming number of these wet pavement accidents. This research determined that the aggregate used in the pavement surface was a large contributor to the friction developed at the tire-pavement interface. The macro- and micro-texture of the aggregates are the primary items in the skid resistance of a pavement surface. This research also determined that these textures, particularly the micro-texture, decrease or smooth out with increasing traffic applications to the pavement surface. This smoothing effect causes a decrease in the friction available at the tire-pavement interface, and, thereby, increases the potential for a wet pavement accident to occur. Other phases of this research confirmed, with facts, what many people felt, that is: certain aggregate and aggregate types do not exhibit the tendency to polish. This confirmation led to what appeared to be a total use of these aggregates throughout the pavement surface matrix. This total use of aggregate was, to a large degree, effective in reducing the number and severity of wet pavement accidents in this country.

This massive use of slower polishing or non-polishing aggregate throughout the pavement matrix, however, created other problems in the fight for the further reduction in wet pavement accidents. The two problems which have caused the most concern are aggregate availability and aggregate price, with the price being directly tied to the availability. These concerns caused additional effort to be spent in determining alternate methods of arriving at a reduction or elimination of wet pavement-caused traffic accidents, but using less of the scarce non-polishing aggregate in the pavement surface matrix.

One method which was tried had been in use for many years in European countries. This procedure is the use of local, economical, and usually plentiful materials to form the pavement matrix while placing a sparse coverage of non-polishing aggregate on the surface of the fresh non-rolled mat. Rolling of the mat then partially embeds the non-polishing aggregate in the surface. The use of these aggregates in the pavement surface provide for increased friction at the point of tire contact with the surface without using the aggregate throughout the pavement matrix. This procedure is called "Sprinkle Treatment" and has proven to be an effective procedure for use in the fight for reduction of wet pavement accidents.

The Texas State Department of Highways and Public Transportation in co-operation with the United States Department of Transportation, Federal Highway Administration (FHWA), Region 15, Demonstration Projects Division, placed a section of sprinkle treatment

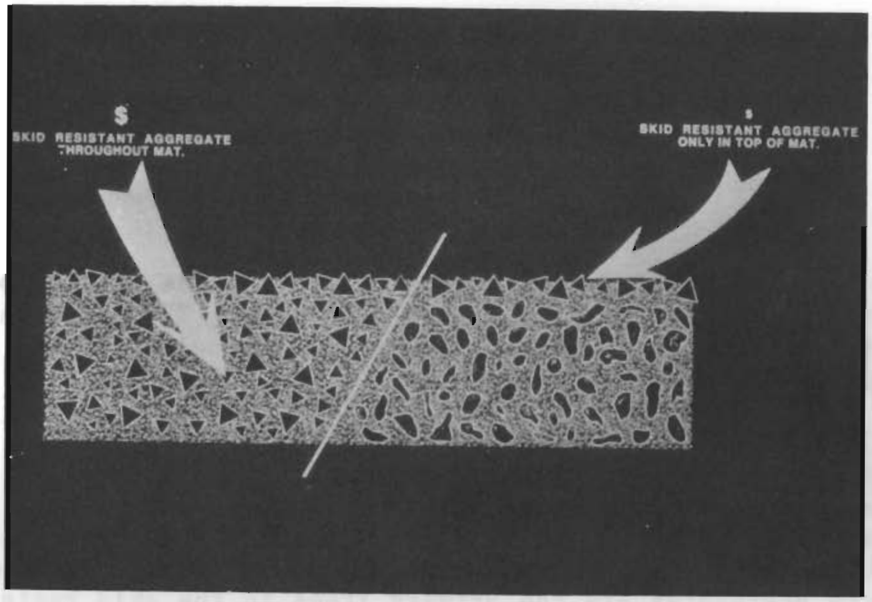


Figure 1
Comparison of Conventional Pavement Matrix with a
Sprinkle Treated Pavement Matrix

on Interstate Highway 20 in the Abilene District. This sprinkle treatment was placed on the final wearing course which was applied to the surface of a hot pavement recycling project. The recycling portion of this project was conducted under FHWA Demonstration Project 39. One purpose of this sprinkle treatment project was to compare placement techniques of heated precoated aggregate and precoated aggregate which had been allowed to cool to ambient air temperature.

DESIGN

The design of the project called for approximately 150#/s.y. of hot mix asphaltic concrete, meeting the following specification gradation, to be placed on the recycled asphaltic concrete pavement:

Texas Type "D" Hot Mix Asphaltic Concrete

	Percent by Weight
Passing 1/2" sieve	100
Passing 3/8" sieve	95 to 100
Passing 3/8" sieve, retained on #4 sieve	20 to 50
Passing #4 sieve, retained on #10 sieve	10 to 30
Total Retained on #10 sieve	50 to 70
Passing #10 Sieve, retained on #40 sieve	0 to 30
Passing #40 Sieve, retained on #80 sieve	4 to 25
Passing #80 Sieve, retained on #200 sieve	3 to 25
Passing #200 Sieve	0 to 6

Asphaltic material shall be from 4 to 8 per cent of the mixture by weight.

The coarse aggregate chosen for the surface course was a polishing limestone. Approximately 5.8% asphalt by weight was used in the mix. The limestone hot mix asphaltic concrete, meeting the above specification requirements, was to be applied on the recycled base at a rate of 150#/s.y.

The sprinkle treatment aggregate (See Figure 2) chosen for this job was predominately a round, synthetic lightweight (approximately 55#/cu. ft.) meeting the following gradation:

	Percent by Weight
Retained on 5/8" sieve..............................	0
Retained on 1/2" sieve..............................	0-5
Retained on 3/8" sieve..............................	60-80
Retained on #4 sieve................................	95-100

Figure 2
Precoated Sprinkle Treatment Aggregate

The synthetic aggregate was required to be precoated with an AC-5 asphalt at the rate of 1-1/2% by weight. The specification penetration as measured by standard test was 135. This aggregate also met the minimum required polish value of 37, as measured by Texas Test 438A (see Appendix C). The specified aggregate distribution rate was 1 c.y. of aggregate for each 200 s.y. of surface area. The aggregate was to be distributed on the unrolled surface by the self-propelled "Bristowes" aggregate spreader from England (see Figure 3). The Bristowes spreader completely spans the fresh mat, thereby eliminating any tracks on the completed mat.

Figure 3
The Bristowes Spreader

This aggregate spreader was chosen because of its history of successful aggregate distribution on sprinkle treatment jobs in England.

CONSTRUCTION

The temperature during construction remained cold to cool (40°-50°F) and the first aggregate placement was to be hot; that is, the precoated aggregate was brought to the job site immediately after pre-coating. As long as the aggregate remained hot, distribution problems were minimal. Since it is difficult to maintain the heated aggregate at a temperature above a "tacky" temperature (while it is in the spreader) on a normal construction day, the cool temperature compounded this problem. This cooling effect caused the sprinkle aggregate to clump together and to be distributed as if it were a bunch of grapes, rather than in an even manner which is necessary for a successful sprinkle treatment job. "Nesting" of aggregates will prevent complete embedment and will result in aggregate loss by traffic and a rougher riding surface. This distribution problem caused any further attempts to place heated aggregate to be discontinued.

The specified sprinkle aggregate placement rate of 1 c.y./200 s.y. proved to be too heavy an aggregate placement for the cold or ambient temperature stone. This heavy distribution rate caused the aggregate "nesting" discussed earlier to occur. A contract field change was developed which modified the distribution rate to 1 c.y. of aggregate/400 s.y. of surface area. This rate of distribution had been proven on sprinkle treatment jobs to be approaching optimum for aggregate retention when the coarse aggregate in the asphaltic concrete hot mix (retained on the #10 sieve) is greater than 50% of the total mix. That is, this is the rate where a majority of sprinkle aggregate placed is retained in the mat.

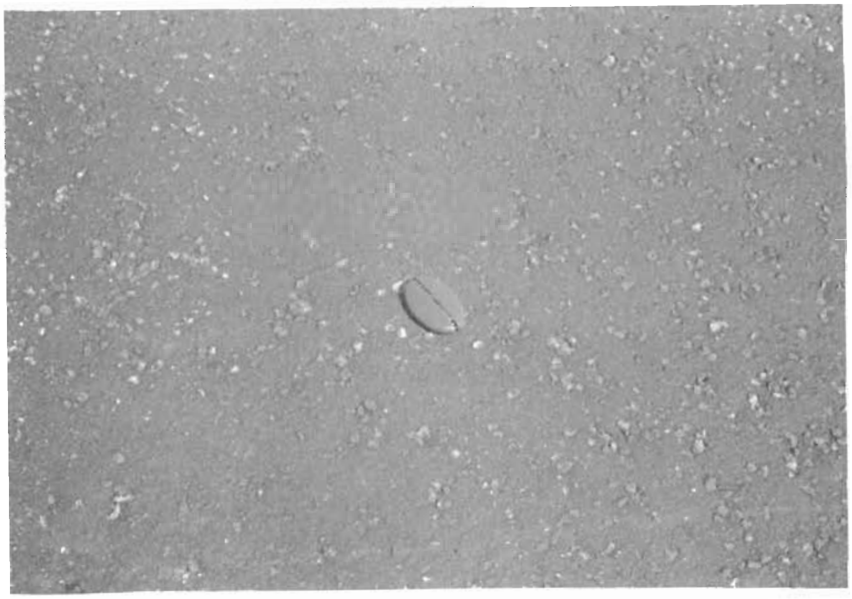


Figure 4
Even Aggregate Distribution

Even with this rate, some problems still existed in the attempts to obtain a uniform aggregate distribution (See Figure 5). One problem was that the grooved roller in the Bristowes spreader easily filled with the fine portion of the sprinkle aggregate causing a blockage of the spreader. This blockage caused delay in that the machine had to be halted periodically for a thorough cleaning. This blockage can be less troublesome if the minus #4 sprinkle aggregate is less than 2% and if the sprinkle aggregate is cool and damp when applied.

Figure 5
Uneven Aggregate Distribution

Another distribution problem which occurred was a shadow effect of transverse, evenly-spaced rows of aggregate which were perpendicular to the center line (See Figure 6).

Figure 6
Transverse Rows of Aggregate

This effect was visually evident when the sun was at a lower angle in the morning or afternoon and was more observed than felt in the ride.

Sprinkle treatment operations are chancy in cool temperatures and almost impossible on very cold, cloudy, or windy days. Rapid surface cooling will not allow complete embedment of the sprinkle rock. Only in a few cases, on this job, did the cold weather (40+$^{\circ}$F) cause loss or crushing of sprinkle aggregate, either by traffic or in the rolling operation.

Figure 7
Rock Loss and Incomplete Embedment

Rolling patterns for this project were not affected by the placement of the sprinkle treatment aggregate. Initial compaction and aggregate embedment was accomplished with the standard three-wheel steel roller, followed by a tandem steel wheel roller. Pneumatic rollers were not used on this job and should not be used on any sprinkle treatment jobs as the pneumatic tires have a tendency to pull the aggregate from the mat. If a pneumatic must be used, sufficient surface cooling must occur to prevent aggregate pick-up or pull-out by the tire.

By using readily available local aggregate in the hot mix asphaltic concrete, the cost of the sprinkle treatment is considerably less than 100% quality aggregate mixes in the same area. On this job the HMAC cost 90¢/sq.yd. and the sprinkle treatment aggregate cost 5¢/sq.yd. where as an open graded friction course placed at approximately the same time, cost \$2.69/sq.yd.

EVALUATION

The evaluation of this project was two-fold, consisting of a skid resistance (SN_{40}) and a visual examination for aggregate degradation, aggregate loss, etc.

The skid performance was measured periodically by a locked-wheel skid measurement system conforming to ASTM E-274.

Figure 8
Skid Testing

Table 1 shows the skid performance of this sprinkle treatment section and its corresponding total traffic applications. The job was completed May 15, 1978.

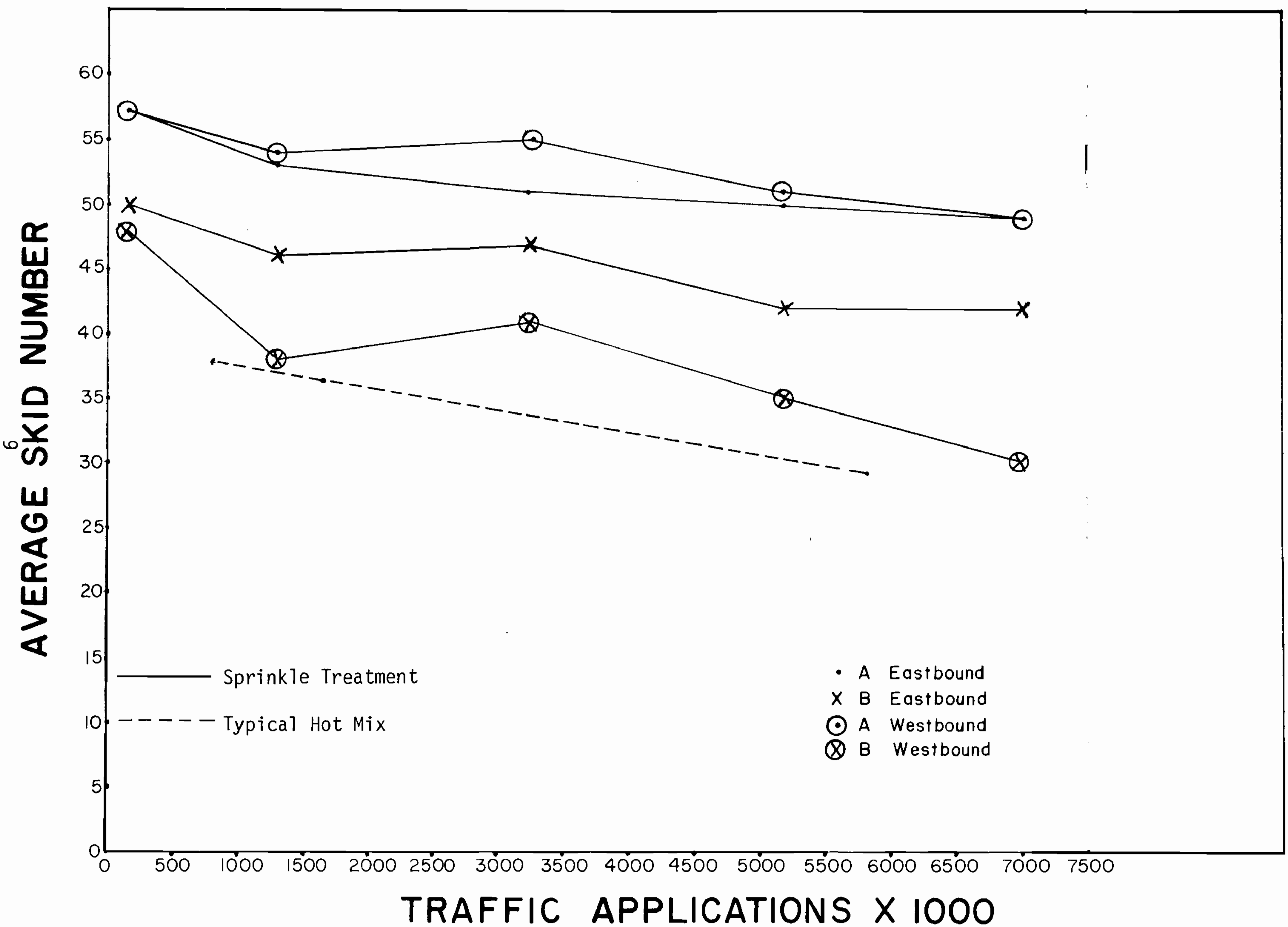
TABLE 1

DATE TESTED	LANE* DIRECTION	SN 40 Low/Avg/High	Total Traffic Applications**
5/78	A-Eastbound	49/57/65	162,000
9/78	A-Eastbound	45/53/59	1,296,000
3/79	A-Eastbound	46/51/57	3,240,000
9/79	A-Eastbound	45/50/59	5,184,000
2/80	A-Eastbound	43/49/53	6,966,000
5/78	B-Eastbound	44/50/54	162,000
9/78	B-Eastbound	39/46/53	1,296,000
3/79	B-Eastbound	40/47/50	3,240,000
9/79	B-Eastbound	38/42/49	5,184,000
2/80	B-Eastbound	36/42/46	6,966,000
5/78	A-Westbound	52/57/64	162,000
9/78	A-Westbound	48/54/59	1,296,000
3/79	A-Westbound	49/55/59	3,240,000
9/79	A-Westbound	46/51/55	5,184,000
2/80	A-Westbound	43/49/53	6,966,000
5/78	B-Westbound	41/48/53	162,000
9/78	B-Westbound	28/38/49	1,296,000
3/79	B-Westbound	30/41/50	3,240,000
9/79	B-Westbound	28/35/39	5,184,000
2/80	B-Westbound	26/30/35	6,966,000

*Lane A, the passing lane, is the lane nearest the median, and lane B is the next lane over or the travel lane.

**Total traffic is the number of days in place multiplied by the Average Daily Traffic of the roadway. Texas methods of collecting daily traffic preclude any breakdown of traffic by direction or lane.

Lane B in the west-bound direction is a section in which the asphaltic binder in the base and surface has flushed to the surface. This would be an extremely slick condition if it were not for the sprinkle aggregate in the surface of the roadway.



AVERAGE SKID NUMBER
6
60
55
50
45
40
35
30
25
20
15
10
5
0
0
500
1000
1500
2000
2500
3000
3500
4000
4500
5000
5500
6000
6500
7000
7500
TRAFFIC APPLICATIONS X 1000
Sprinkle Treatment
Typical Hot Mix
A Eastbound
B Eastbound
A Westbound
B Westbound

The visual examination portion of this evaluation was accomplished by a team composed of 5 members from the following fields of expertise:

(1) Research
(2) Design
(3) Construction
(4) Maintenance
(5) Materials and Tests

Each team member was required to complete the form in Appendix B. These members visited the site independently and completed the form shown as B-1. These values were then recorded and averaged on the Form marked as B-2.

The ratings by the team show that very little rock loss occurred after the initial opening of the sprinkle-treated facility to traffic. A maximum loss of approximately 5% of the aggregate occurred. Also, aggregate degradation occurred no differently than would be expected in any situation where the non-polishing aggregate pieces are exposed to action by traffic. Placement of the aggregate on a mat too cold to allow for proper embedment of the sprinkle rock can result in aggregate degradation or crushing by the roller.

Percent aggregate embedment is very critical. Insufficient embedment will cause aggregate loss by traffic, whereas 100%+ embedment will cause the loss of needed skid resistance. The outside west-bound lanes exhibit an average aggregate embedment of 97% while the outside east-bound lanes have an average embedment of 85%. The previously discussed skid numbers indicate this aggregate embedment depth to be an important factor in determining the skid resistance life of a sprinkle-treated roadway. Initial embedment of 90-95% of the aggregate is desired. Since the pavement matrix is usually softer than the sprinkle treatment aggregate, traffic will erode the mat leaving an embedment depth of 80-85%. This depth is sufficient to maintain the aggregate in the mat, while giving enough texture to provide adequate skid resistance for the pavement life.

The percent surface area covered by sprinkle aggregate was the most difficult item for the team to determine. To assist in this determination, photographs of various percentages of surface coverage were prepared. Figure 9, an example, depicts a 25% surface coverage.

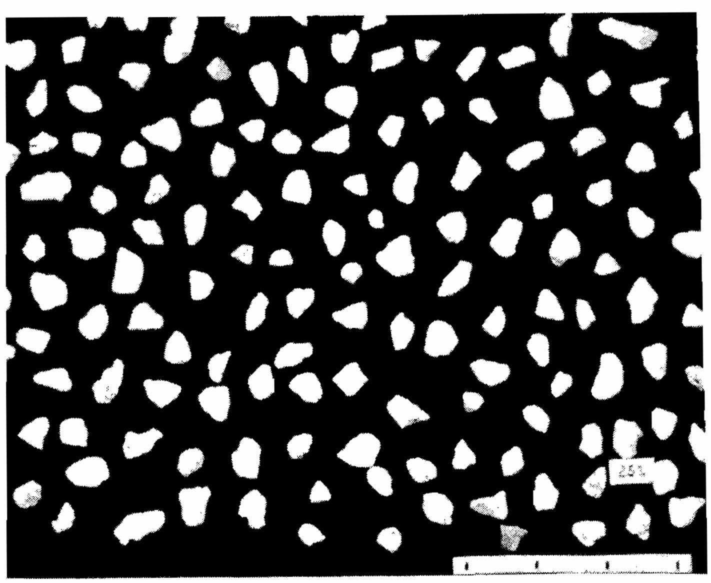


Figure 9
25% Aggregate Coverage

CONCLUSIONS AND RECOMMENDATIONS

1. Sprinkle treatment is effective in providing a skid-resistant surface while conserving generally scarce non-polishing aggregates.

2. Sprinkle treatment aggregate should always be precoated with sufficient asphalt to aid in aggregate retention.

3. Job quality can be affected by the placement of heated aggregate if the temperature of the aggregate is not maintained above the "tacky" temperature, the temperature at which the aggregate begins to stick to itself. Additionally, a short delay in the hot mix laydown operation will generally cause the aggregate to reach this "tacky" temperature. Normal plant production of the hot mix asphaltic concrete must be interrupted in order to produce and deliver to the job site heated, precoated sprinkle aggregate.

4. As in any pavement design, care should be taken to prevent excess asphalt from being placed in the base or surface matrix. Asphalt flushing to the surface will decrease the skid resistance ability of any aggregate.

5. Pneumatic tired rollers should not be used on sprinkle treatment jobs unless the roadway surface has cooled sufficiently to prevent aggregate pick-up and/or pull-out by the pneumatic tires.

6. Excessively high quantities of aggregate placed on the roadway surface will cause "nesting" of the aggregates which will prevent complete embedment of the stone, resulting in aggregate loss and possibly a rougher riding surface.

7. Sprinkle treatment procedures work very well on warm to hot days, but are very chancy if not impossible on cool to cold days. Surface cooling of the mat will not allow for the complete and necessary embedment of the aggregate.

8. Care should be taken to insure that the aggregate spreader is in proper operating condition. There should be no eccentric rollers in the spreader, and all aggregate distribution ports should be carefully observed to prevent clogging by sprinkle aggregate.

9. Aggregate distribution rate should be periodically checked to insure that the spreader has not changed the desired rate of coverage. A good way to measure distribution rates is by passing the spreader over a cloth of known size, then weighing the material left on the cloth.

10. Sprinkle aggregate embedment depth is of extreme importance in that too little embedment will allow the aggregate to be pulled out of the surface by the vehicle tires; too much embedment will decrease the available friction at the tire-pavement interface. 80-85% embedment after 1 year of service is optimum for aggregate retention and available skid resistance.

APPENDIX A

SPRINKLE TREATMENT EVALUATION SUMMARY SHEET

SECTION 2-8

EVALUATION 3rd

DISTRICT 8-Abilene

HIGHWAY I.H. 20

COUNTY Nolan

CONTROL SECTION 6-2

FROM: 1 mile west of Roscoe TO: 1.5 miles east of Roscoe

	RATER	Mounce	Peck	Hughes	Underwood	Larrimore		AVG.	STD. DEV.
	DATE RATED	7/18/79	7/25/79	8/28/79	9/17/79	7/17/79			
	ABOVE/BELOW STANDARD DEVIATION	1/1	2/0	1/1	0/2	3/3			
	VISUAL EXAMINATION	7.9	+9.0	7.8	8.8	-7.3		8.16	0.72
HOT MIX	1. Structural Condition	8.0	+9.0	8.2	8.8	-7.7		8.34	0.55
	2. Flushing	-7.5	8.0	+9.0	8.5	8.0		8.20	0.57
SPRINKLE TREATMENT	1. Aggregate Degradation	8.0	8.0	8.4	8.0	+9.0		8.28	0.44
	2. Aggregate Loss	7.4	7.8	7.4	-6.3	+9.0		7.58	0.97
	3. Transverse Distribution	7.4 *	7.2 *	-6.4 *	7.8 *	+8.0 *		7.36	0.62
	4. Longitudinal Distribution	7.2 *	7.8 *	6.4 *	-5.0 *	7.7 *		6.82	1.16
	5. % Aggregate Embedment	89.0	90.0	90.0	86.3	-70.0 *		85.06	8.55
	6. % of Surface Covered	+31.0	20.0	20.0	20.0	18.8 *		21.96	5.08

* from previous evaluation

APPENDIX B

RATER:________________

JOB EVALUATION

Section______

Visual Examination

0 .	2 .	4 .	6 .	8 .	10
very poor	poor	fair	good		very good

HOT MIX

1. Structural Conditon

0 .	2 .	4 .	6 .	8 .	10
very poor	poor	fair	good		very good

2. Flushing

0 .	2 .	4 .	6 .	8 .	10
excessive & extensive	moderate		slight flushing		none

SPRINKLE TREATMENT

1. Aggregate Degradation

0 .	2 .	4 .	6 .	8 .	10
excessive	heavy	moderate		slight	none

2. Aggregate Loss

0 .	2 .	4 .	6 .	8 .	10
all lost	heavy loss	moderate loss		slight loss	no loss

3. Transverse Distribution

0 .	2 .	4 .	6 .	8 .	10
very poor	poor	fair		good	very good

4. Longitudinal Distribution

0 .	2 .	4 .	6 .	8 .	10
very poor	poor	fair		good	very good

5. %Aggregate Embedment____%(Note: Depth of Sprinkle Aggregate in the Mat)

6. Estimated Percent of Surface Area Which is Covered by Sprinkled Aggregate______%

REMARKS

SPRINKLE TREATMENT EVALUATION SUMMARY SHEET

SECTION____________________

EVALUATION____________________

DISTRICT____________________

HIGHWAY____________________

COUNTY____________________

CONTROL SECTION____________________

FROM:______________________________________ TO:______________________________________

	RATER								
	DATE RATED								
	ABOVE/BELOW STANDARD DEVIATION							AVG.	STD. DEV.
16	VISUAL EXAMINATION								
HOT MIX	1. Structural Condition								
	2. Flushing								
SPRINKLE TREATMENT	1. Aggregate Degradation								
	2. Aggregate Loss								
	3. Transverse Distribution								
	4. Longitudinal Distribution								
	5. % Aggregate Embedment								
	6. % of Surface Covered								

* from previous evaluation

APPENDIX C

State Department of Highways and Public Transportation

Materials and Tests Division

ACCELERATED POLISH TEST FOR COARSE AGGREGATE

Scope

This test method describes a procedure for determining a relative measure of the extent to which aggregate in the wearing surface of the roadway will polish under traffic.

The aggregate samples under test are mounted on a specimen wheel to form a test strip 16 inches in diameter and subjected to the rolling action of a rubber tire. Size 150 silicon carbide grit and water are used to increase the rate of wear.

Part I of this method covers testing of single component aggregate samples and determining the Polish Value by using the Wessex Accelerated Polishing Machine and the British Portable Tester.

Part II of this method differs from Part I only in the use of two-component blends of aggregate particles rather than a single type of aggregate. Method A of Part II covers the determination of Polish Value of blends by actual testing. Method B of Part II covers the theoretical determination of Polish Value or blend percentage by use of a formula.

Part III describes a procedure for determining the amount of differential wear on individual particles of aggregate subjected to similar abrasive action by measuring quantitatively the loss of particle surface.

PART I
SINGLE COMPONENT AGGREGATE

The Polish Value is determined in accordance with ASTM Designation: E 303, Measuring Pavement Surface Frictional Properties Using the British Portable Tester.

Definitions

Initial Friction Value: The average of a set of initial readings on the test specimens before they are polished in the accelerated polishing machine.

Polish Value: The average of a set of readings on the test specimens after nine hours of polishing in the accelerated polishing machine.

Sampling

A 30-pound sample representing production designated for highway use shall be submitted by a representative of the State Department of Highways and Public Transportation. The sample shall be properly identified on Form 202 and the name of the pit or quarry and its exact location shall be explicit.

Apparatus

1. A Wessex Accelerated Polishing Machine based on a 1958 design by the Transport and Road Research Laboratory of Great Britain.

2. Metal Molds to form a test specimen 3.50 inches long by 1.75 inches wide by 0.63 inches deep.

3. A British Portable Tester to measure the Initial Friction Value and the Polish Value of the test specimens.

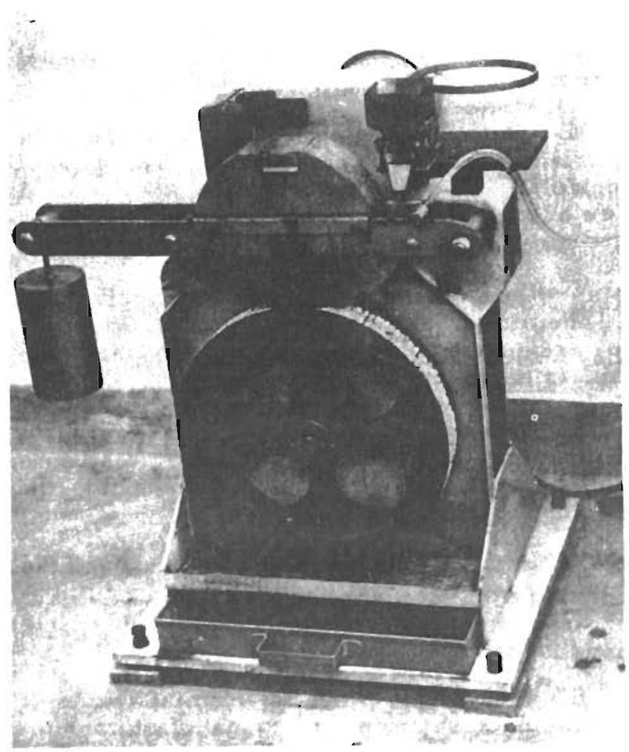


Figure 1

Wessex Accelerated Polishing Machine Showing Test Specimens Mounted on Specimen Wheel

Materials

1. Tap water.

2. Ottawa sand, Grade 20-30 meeting ASTM Designation: C 190. This material is optional.

3. Polyester resin and catalyst for bonding agent with a pot life of about 10 minutes and a curing time of 3-6 hours.

4. Mold release agent for use with polyester bonding agent. This material is optional.

5. Silicon carbide grit (150 size).

6. A supply of disposable cups and spatula or stirring rods for use in mixing the bonding agent.

Preparation of Test Specimens

Seven specimens are required for each material and are to be prepared as follows:

1. The aggregate to be tested shall pass the 1/2-inch sieve and be retained on the #4 sieve.

2. The screened aggregate shall be thoroughly washed clean and dried.

3. The molds shall be coated with the mold release agent (optional).

Note: A mold release agent may be used to facilitate release of the coupon. Generally a polyester compound does not require this agent.

4. The aggregate particles shall be placed in a single layer as closely as possible in the bottom of the mold. Aggregate particle orientation should allow adequate surface area for polishing as well as bonding.

Note: When possible, use of flat, elongated and odd-shaped particles should be avoided. Generally they will cause difficulty in placement and will result in erratic or biased Polish Values.

5. The interstices between the aggregate particles may be filled with the Ottawa sand to a depth between 1/4 to 1/2 the particle height. This step is optional.

Note: The Ottawa sand is needed as a barrier if the bonding agent has high fluidity. Generally a putty-like consistency of bonding agent eliminates the need for sand.

6. Prepare the polyester resin and catalyst for bonding agent according to manufacturer's instructions. The consistency of the polyester shall be such as to allow it to spread onto and between the particles, but not so thin that it flows into the Ottawa sand (if sand is used) and onto the curved mold surface.

7. Fill prepared mold to capacity with the polyester bonding agent.

8. Strike off the bonding agent level with the curved sides of the mold.

9. Leave specimen in the mold for a sufficient length of time (3-6 hours) to allow the bonding agent to cure properly.

10. Remove specimen from the mold and brush any excess sand from the specimen face (if sand was used).

11. Dress the bottom side of the test specimens with a grinding wheel or belt sander if warping prevents proper placement on the polishing wheel or BPT base plate.

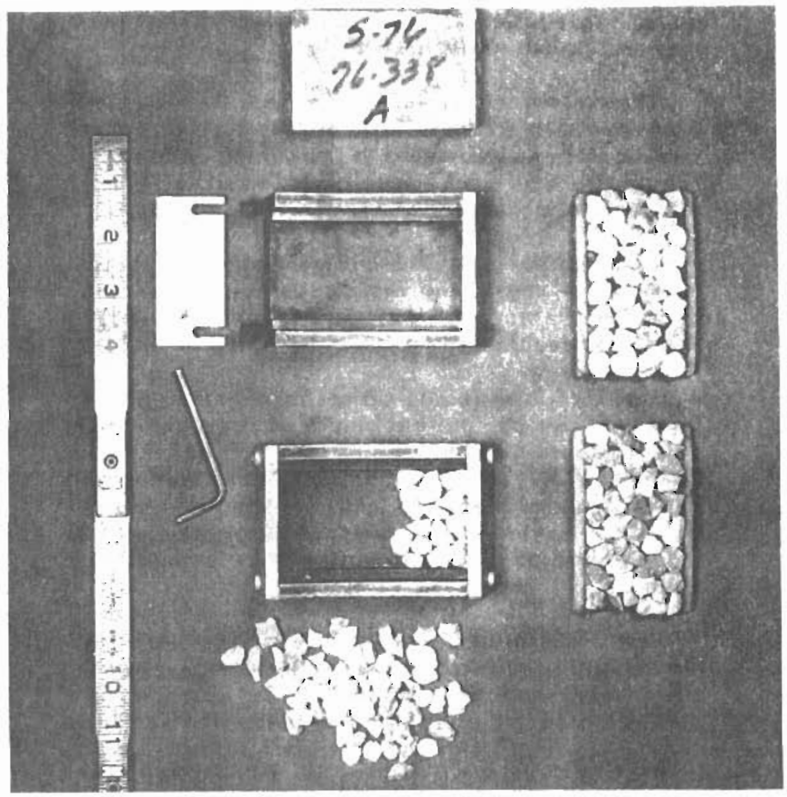


Figure 2

Metal Molds With Test Specimens

Procedure

1. Calibrate the British Portable Tester.

2. Determine the Initial Friction Value of the prepared test specimens. The Initial Friction Value is used for reference purposes.

3. A total of 14 specimens shall be clamped around the periphery of the specimen wheel of the Wessex Accelerated Polishing Machine. A rubber O-ring is placed on both edges of the test specimens to hold them against the specimen wheel. The wheel flanges are then bolted into place pressing down upon the O-rings and edges of the specimens firmly holding them in place.

A minimum of seven specimens of each material shall be tested to increase statistical accuracy. Dummy specimens may be used to completely fill the wheel if only one material is to be tested. The outer surfaces of the specimens shall then form a continuous strip of particles upon which the rubber tire shall ride freely without bumping or slipping.

4. The specimen wheel shall be brought to a speed of 320 ± 5 rpm. The rubber tire wearing wheel, inflated to 45 ± 2 psi, shall be brought to bear against the specimen wheel and loaded to 88 ± 1 pounds.

5. Silicon carbide grit (size 150) shall be continuously fed to the specimen wheel near the tire contact point at a constant rate of approximately 6 ± 2 grams per minute along with water fed at the rate of about 50 to 75 milliliters per minute.

6. The polishing action shall be continued for a total period of nine hours. Downtime does not affect test results.

7. The samples shall be removed from the specimen wheel and washed thoroughly to remove grit.

8. After cleaning, the samples shall be tested for Polish Value with the British Portable Tester.

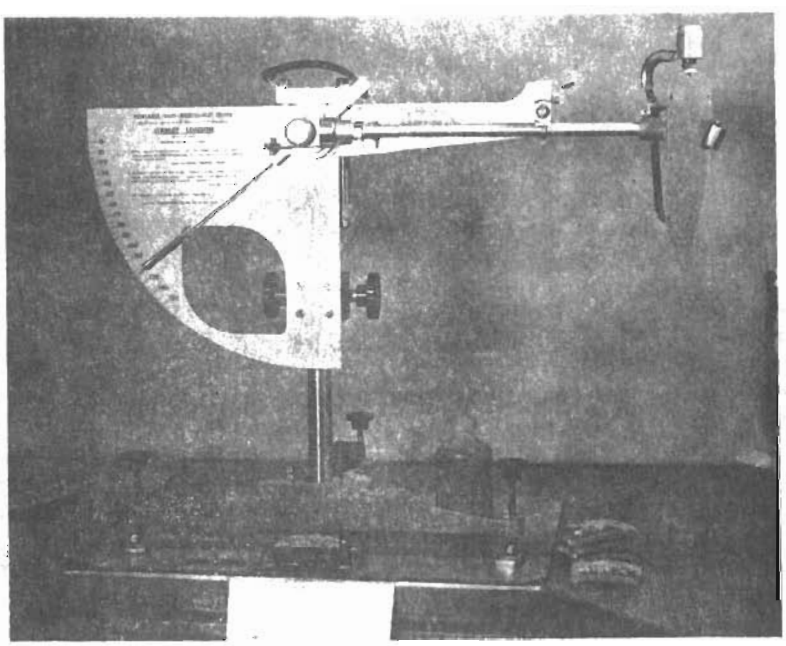


Figure 3
British Portable Tester

Report

The final report shall consist of the average final Polish Values.

PART II
BLENDED AGGREGATES

This part describes the additional steps to be taken when aggregate blends are tested as differentiated from single-component aggregates.

Definitions

Blend – A definite percentage mixture of two materials of different physical characteristics from different locations.

Note: Unless specific exceptions are noted, all apparatus, materials and procedures are identical with those outlined in Part I.

Method A – Determination of Polish Value for Random Blends

Sampling

The aggregate particles are selected on a percentage basis (i.e., 1 particle to 9 for a 10% blend, or 1 particle to 4 for a 20% blend, etc.). Although selection of particles is random, some care should be exercised in avoiding a preponderance of odd-shaped particles (such as flakes or blades) for either component.

Preparation of Test Specimens

Aggregate particles in the correct percentages are placed at random on the bottom of the mold. Preparation of the test specimen is then completed as outlined in Part I. Seven coupons are made for each blend to be tested. For aggregate percentages to be properly representative, the two aggregates which are to be blended must be similar in size.

Report

Information in the report for aggregate blends shall include the following:

1. Information from Form 202.

2. Initial Friction Values and the average for each aggregate and each blend tested.

3. Final Polish Values and the average for each aggregate and each blend tested.

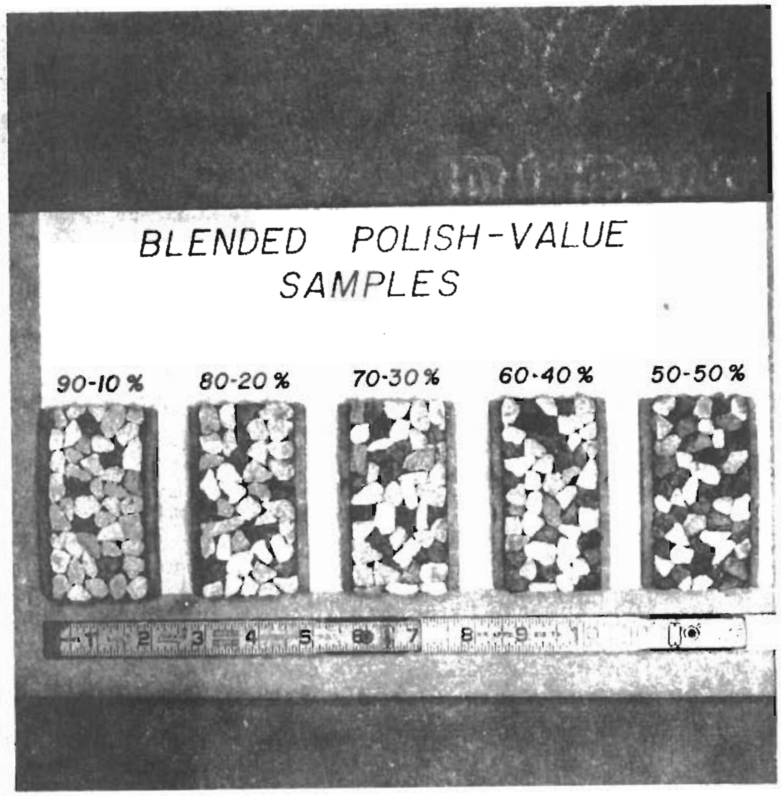


Figure 4

Specimens of Various Percentage Blends

Method B – Theoretical Determination of Polish Value and Blend Percentage

Definitions

Non-polishing aggregate – An aggregate used to improve the polish value of the aggregate mix.

Polishing Aggregate – An aggregate exhibiting a relatively low polish value which needs to be improved.

The percentage by volume of non-polishing aggregate to use in a blend to meet a specified Polish Value is determined by the following formula:

$$\%P_R = \frac{100\ [(PV_S + 2) - PV]}{PV_R - PV}$$

$\%P_R$ = Percent (by volume) of the Non-polishing coarse aggregate

PV_S = Polish Value required by specification

PV_R = Polish Value of Non-polishing aggregate (P_R)

PV = Polish Value of polishing aggregate to be improved

The Polish Values of the components above are determined as in Part I using single component aggregate coupons.

PART III
DETERMINATION OF DIFFERENTIAL WEAR

Part III Describes a procedure for determining the amount of wear on individual particles of coarse aggregate by measuring the actual loss of the particle surface as it is abraded on the Accelerated Polishing Machine.

Apparatus

1. Specimen molds and supplies as in Part I.

2. Wessex Accelerated Polishing Machine as in Part I.

3. Height measuring dial gage affixed to the frame of the Polishing Machine as shown in Figure 5. The gage should be accurate to 0.001 inch.

Preparation of Test Specimens

A sufficient number of specimens should be made to obtain a valid average figure for each type of aggregate or blend or composite of aggregates to be tested. Preparation of test specimens is identical to that of Part I. The aggregate particles of the different types are selected at random and placed at random on the bottom of the mold.

An alternate method to measure wear on aggregate particles retained in separate type groups, uses a divider such as the one shown in Figure 6 to keep particles in quadrants. The divider is removed before application of the polyester bonding agent.

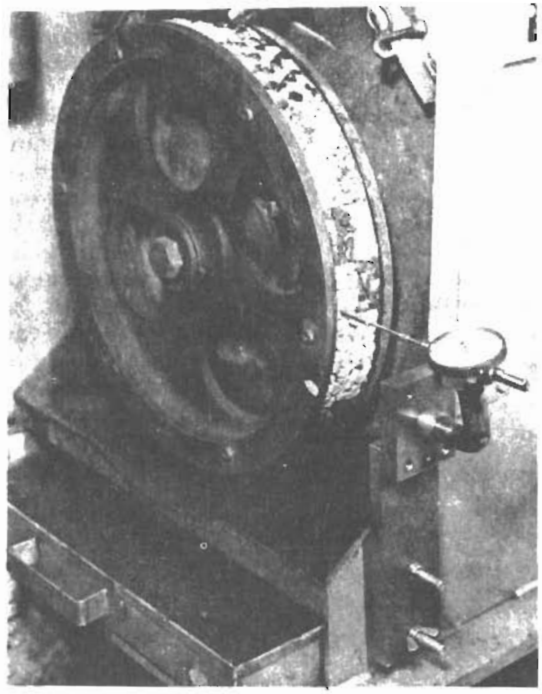


Figure 5

Polishing Machine with height gage

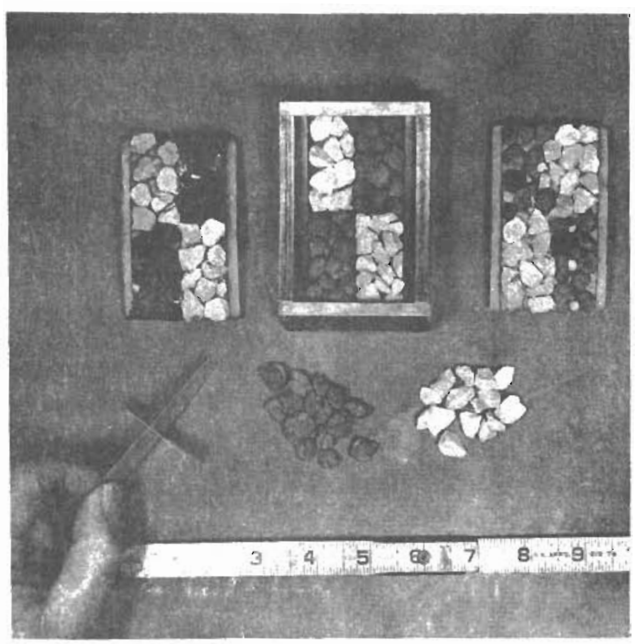


Figure 6

Divider used for separating aggregate in quadrants

Procedure

1. Mount the test coupons on the Accelerated Polishing Machine wheel as in Part I.

2. Zero the height measuring gage on a cleaned and marked spot on the wheel flange.

3. Mark with a fast-drying contrasting color paint the individual particles to be measured. A minimum of eight particles per coupon should be marked on the side. In this location the paint will not wear.

4. Measure and record the surface elevation of each marked particle of aggregate.

5. The wheel is run nine hours for the full test, but it may be stopped at set periods for measurement of wear in order that a set of values may be taken for rate-of-wear graphs.

6. Final height measurements are taken on the marked aggregate particles at the end of the nine-hour run. The loss of height is then averaged for each type of aggregate tested. These averages represent an index of differential wear or comparison between the particular aggregates tested in the given composition coupon.