REFER TO:	Action	Info	Int
Materials Engineer		✓	
Assoc. Mat'ls Engr. I		✓	
Assoc. Mat'ls Engr. II		✓	
Soils Engineer		✓	
Geologist		✓	
Testing Engineer			
Office Manager			
Quality Control			
Project Development			
E.I.T.			
Chem. Asphalt			
Mixes Strus.			
Aggregate & Soils			

HRB

Special Report 117

Bituminous Aggregate Base Course Survey of State Practices

HIGHWAY RESEARCH BOARD

NATIONAL RESEARCH COUNCIL
NATIONAL ACADEMY OF SCIENCES NATIONAL ACADEMY OF ENGINEERING

Special Report 117

Bituminous Aggregate Base Course: Survey of State Practices

Subject Areas

31 Bituminous Materials and Mixes
33 Construction

HIGHWAY RESEARCH BOARD
DIVISION OF ENGINEERING NATIONAL RESEARCH COUNCIL
NATIONAL ACADEMY OF SCIENCES—NATIONAL ACADEMY OF ENGINEERING

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PREFACE

Bituminous aggregate bases, commonly referred to as "black bases," or "bituminous bases" are not new to the paving industry. Although they have been referred to by other terminology, records indicate that "black bases" of one type or another have probably been in use for many years. Yet, it is only within the last decade that "black bases" have received prominence as suitable base materials for heavy-duty construction.

Recognizing the need for the dissemination of information evaluating this type of construction, in 1961 the Highway Research Board organized committee MC-A7, whose purpose was to encourage, suggest, formulate, plan, and evaluate research concerning bituminous aggregate bases, including the design of such bases, and to conduct scientific impartial fact-finding surveys of national scope and prepare compilations of current and recommended practices.

All bituminous aggregate bases are included in the scope of this committee except those that contain appreciable quantity of soil or that contain sufficient quantity of bituminous materials to act as a surfacing.

ACKNOWLEDGMENT

Committee MC-A7 gratefully acknowledges the services of the "Summary and Evaluation Subcommittee" composed of: C. F. Parker, Chairman; J. L. Lyons; F. P. Nichols, Jr.; E. T. Perry; D. W. Rand; J. E. Stephens; D. G. Tunnicliff; and L. Tuttle who prepared the questionnaire, conducted the survey, and organized the voluminous information contained in this report.

Acknowledgment is also given to Donald R. Schwartz, incoming chairman of Committee A2-D6 (new designation of Committee MC-A7), who assisted in the final editing of this report.

Paul J. Serafin, Chairman
Committee MC-A7
(Bituminous Aggregate Bases)

INTRODUCTION

This report consists of a tabulation of data obtained from questionnaires sent to the 50 state highway departments, District of Columbia, and Puerto Rico. Response to the questionnaire was 100 percent with many respondents providing additional information.

Information tabulated in this report is extracted from the replies to the questionnaire with as little editing as possible. In some cases it has been necessary to edit replies in order to achieve more or less standard terminology suitable for tabulating. Editing has been held to a minimum, and where it has been necessary only the form, not the substance, of the reply has been changed.

In certain respects, terminology used in the questionnaire was not suitable; yet alternative terminology that would have been better is not available. For example, in considering the names of types of bituminous bound base courses, the subcommittee considered and rejected terms such as "dense graded" and "sand-asphalt" because these terms are not universally used and accepted. Yet, some respondents could not classify their mixtures into the type categories that were used. Some inconsistencies appear elsewhere in the report. Thus, it is apparent that this report is, in part, a tabulation of answers to questions that are subject to interpretation. It is not, in its entirety, a tabulation of facts concerning bituminous bound bases.

Summarization, analysis, or evaluation of the data have not been attempted. As noted above, certain aspects require clarification. Even so, the data are useful and informative in their present form.

The questionnaire survey was forwarded to the state highway departments in August 1969 and returned by the following October. Thus, the results represent current practices employed in bituminous aggregate base course construction by the 50 state highway departments, the District of Columbia, and Puerto Rico during 1969.

ENVIRONMENTAL CONDITIONS

STATE	PRECIPATION (inches)	FROST DEPTH (inches)	FREEZING INDEX (Depree Days)	SNOWFALL (inches)
Alabama	48-54-64	not available	0	1-2-4
Alaska	6-16-150	12-100	not available	28-100-400*
Arizona	4-12-32	0-13	0-0-100	1-12-60
Arkansas	44-52-56	0-6	0	2-2-6
California	4-20-96	Neg.	0	0-24-300*
Colorado	8-16-40	24-36	100-500-1500	36-100-400*
Connecticut	44-46-48	30	250-500-750	60
Delaware	44-44-44	12	250-250-500	12-12-24
Dist. of Col.	40-44-48	8-12	250-250-500	12-12-24
Florida	40-52-64	Neg.	0	Neg.
Georgia	44-48-52	5-20	0	1-1-4
Hawaii	16-32-300	Neg.	0	Neg.
Idaho	8-32-48	12-96	250-750-1250	36-60-200*
Illinois	32-32-48	10-30	0-250-750	12-24-36
Indiana	40-42-44	not available	0-100-500	12-24-36
Iowa	32-32-32	36	500-750-1500	24-24-36
Kansas	20-28-32	0-12	0-100-250	12-24-24
Kentucky	44-48-48	12-18	0	12-12-24
Lousiana	56-60-64	Neg.	0	1-1-2
Maine	36-40-48	36-72	1000-1750-2250	60-100-100*
Massachusetts	44-48-52	30-60	500-750-750	36-60-60
Maryland	40-44-48	10-30	250-500-500	12-12-24
Michigan	28-28-32	24-60	500-750-1250	36-60-100
Minnesota	24-28-32	54-84	1250-2250-3000	36-36-60
Mississippi	48-56-64	Neg.	0	1-2-4
Missouri	36-40-44	0-12	0-100-500	12-12-24
Montana	12-16-32	48-84	500-1250-2250	24-60-200*
Nebraska	16-20-32	24-48	250-750-1000	24-24-36
Nevada	4-8-16	0-48	0-180-250	12-36-60
New Hampshire	44-44-74	60	1000-1250-1750	60-100-100*
New Jersey	44-44-48	24-48	0-100-250	12-24-24
New Mexico	8-16-20	Variable	0-0-500	4-24-60*
New York	44-48-48	18-48	500-1000-1250	36-72-100*
North Carolina	40-52-52	0-6	0	0-1-1
North Dakota	16-16-20	36-78	1500-2250-3000	36
Ohio	32-40-40	36-48	0-100-500	24-24-36
Oklahoma	24-32-40	10-26	0	6-6-12
Oregon	12-32-96	48	0-250-500	12-100-300*
Pennsylvania	40-40-44	20-52	0-250-500	24-36
Puerto Rico	40-64-100	Neg.	0	Neg.
Rhode Island	44-48-48	36	100-100-250	24-36-36
South Carolina	44-44-56	Neg.	0	1-2-4
South Dakota	16-16-24	28-60	750-1250-2000	36
Tennessee	48-52-56	0-8	0	4-6-12
Texas	8-32-52	0-6	0	1-2-12
Utah	8-16-24	0-12	100-500-750	12-48-100*
Vermont	36-40-44	48-72	1000-1250-1500	60-100-100*
Virginia	40-44-48	0-6	0	6-12-24
Washington	8-48-150	15	0-250-750	12-100-400*
West Virginia	44-48-48	not available	0	36-36-100
Wisconsin	28-32-36	48-60	1000-1500-2250	26-48-100
Wyoming	8-12-40	Variable	500-1000-1750	24-60-200*

PRECIPATION Shows average ranges according to "Environmental Science Services Admin.-1966". Middle figure is the estimated mean for the State. Melted snowfall is included.

SNOWFALL DATA Information obtained from Public Roads Journal Feb. 1969, p. 150. Middle figure is estimated mean for the State. Asterisks* indicate a wide variation occurs due to local conditions.

FROST DEPTH Data as reported by agencies answering this questionnaire.

FREEZING INDEX Mean air freezing index is cumulative degree days below 32°F on basis of mean air temperature data. Information obtained from Army Technical Manual TM 5-818-3 or Air Force Manual AFM 88-24. Middle figure is the estimated mean for the State.

The weather data in this table was obtained by gathering values from maps. Actual conditions may vary considerably due to local conditions. This data is presented primarily for nation wide comparative purposes. Frost Depth Data was obtained from the Base Study Questionnaire.

GENERAL INFORMATION - BITUMINOUS BASES - TONS PER YEAR

State	Reporter	All Types Tons	Macadam	Mixed in Place	Crs. Aggr. Pl. Mix Hot	Crs. Aggr. Pl. Mix Cold	Fine Aggr. Plant Mixed	Other Types	Placed Under Port. Cement Conc. Pavement
Alabama	J. F. Tribble	559,000	None	Negligible	559,000	None	None	None	None
Alaska	R. D. Shumway	None	None	None	None	None	None	None	None
Arizona	G. J. Allen	160,975	None	30,325	130,650	None	None	None	None
Arkansas	J. D. Magness	135,000	None	None	100,000	20,000	15,000	None	None
California	J. Beaton	50,000	None	None	50,000	None	None	None	None
Colorado	T. C. Reseigh	No record	None	None	No record	No record	No record	None	None
Connecticut	H. S. Ives	240,000	None	None	240,000	None	None	None	None
Delaware	S. Scarborough	36,790	None	None	6,290	None	30,500	None	None
Dist. of Col.	L. G. Martin, Jr	35,000	None	None	35,000	None	None	None	None
Florida	W. G. Gartner, Jr	350,000	None	None	None	None	350,000	None	None
Georgia	L. G. Adams	320,000	Limited	None	155,000	None	165,000	None	None
Hawaii	T. Aratani	2,500	None	None	2,500	None	None	None	None
Idaho	L. F. Erickson	452,485	None	None	452,485	None	None	None	None
Illinois	J. E. Burke	3,100,000	None	Negligible	3,100,000	Negligible	None	None	1,700,000
*Indiana	J. Hagerty & S. R. Yoder	852,008	None	None	771,620	8,000	None	72,388*	None
Iowa	B. H. Ortgies	1,500,000	None	None	1,100,000	400,000	None	None	350,000
Kansas	G. N. Clark	775,000	None	None	775,000	None	None	None	None
Kentucky	W. B. Drake	620,000	None	None	620,000	None	None	None	None
Louisiana	V. Adams	None	None	None	Unknown	None	None	None	None
Maine	R. A. Standley, Jr	84,000	None	1,000	70,000	13,000	None	None	None
Mass.	J. J. Lyons	1,000,000	Minor	None	1,000,000	None	None	None	None
Maryland	N. L. Smith	580,000	None	None	464,000	88,000	28,000	None	None
Michigan	P. J. Serafin	69,000	None	None	69,000	None	None	None	None
Minnesota	F. C. Fredrickson	1,210,069	None	160,210	831,492	218,367	None	None	None
Mississippi	R. W. Thomas	346,842	None	None	346,842	None	None	None	None
Missouri	R. M. Rucker	550,000	None	None	550,000	None	None	None	None
Montana	G. O. Jespersen	227,000	None	None	113,500	113,500	None	None	None
Nebraska	L. J. Bryant	235,000	None	125,000	110,000	None	10,000	None	None
Nevada	J. Desmond	366,610	None	None	366,610	None	None	None	None
N. Hampshire	R. F. Lassonde, Jr	80,000	None	None	80,000	None	None	None	None
New Jersey	J. C. Reed	529,300	13,300	None	500,000	None	None	16,000 Soil Aggr. Emulsion	None
New Mexico	W. W. Guthrie	No record	None	None	No record	None	None	None	None
New York	H. H. McLean & Wm. P. Hofmann	1,110,000	None	None	1,100,000	10,000	None	None	None
No. Carolina	M. R. Sproles	1,785,600	None	17,600	1,068,000	None	700,000	None	None
No. Dakota	R. Reich	1,400,000	None	None	400,000	1,000,000	None	None	None
Ohio	G. J. Thormyer	2,060,000	160,000	None	1,900,000	None	None	None	100,000

GENERAL INFORMATION - BITUMINOUS BASES - TONS PER YEAR (Continued)

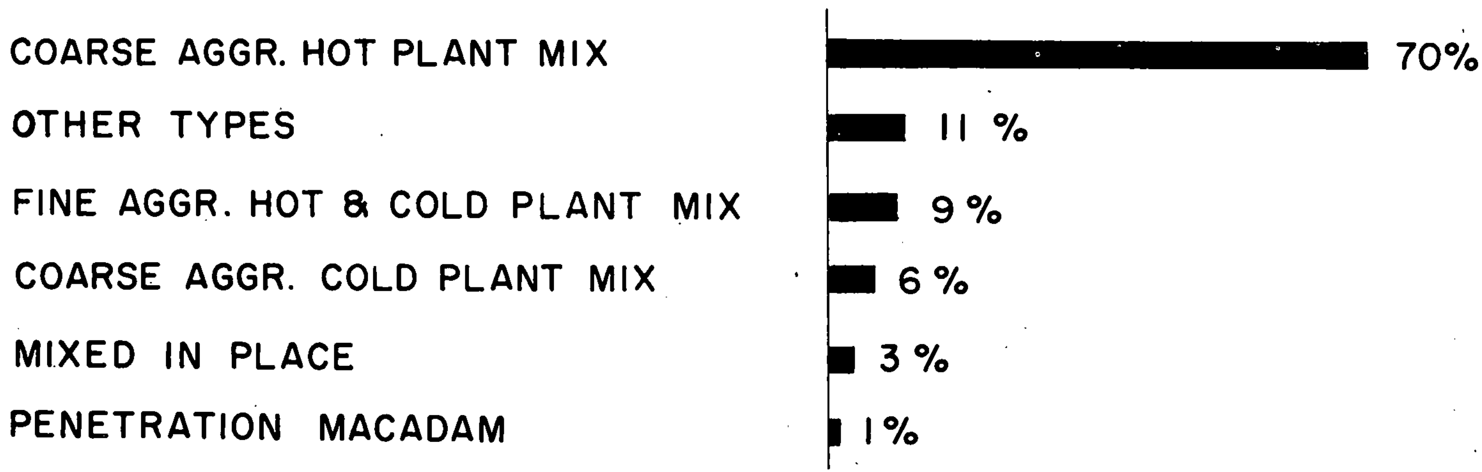
State	Reporter	All Types Tons	Macadam	Mixed in Place	Crs. Aggr. Pl. Mix Hot	Crs. Aggr. Pl. Mix Cold	Fine Aggr. Plant Mixed	Other Types	Placed Under Port. Cement Conc. Pavement
Oklahoma	F. P. Hicks	4,722,310	None	None	143,876	None	778,434	3,800,000 Soil Asph. (MC Asph.)	250,000
Oregon	G. L. Decker	75,000	None	None	75,000	None	None	None	None
Pennsylvania	L. D. Sandvig	1,400,000	None	None	1,200,000	200,000	None	None	None
Puerto Rico	R. M. Alonso & E. Serbia	274,000	None	None	274,000	None	None	None	None
Rhode Island	R. Fruggiero	502,000	70,000	None	162,000	None	270,000	None	None
So. Carolina	O. S. Fletcher	1,127,000	None	46,000	105,000	None	976,000	None	None
So. Dakota	R. Walker	290,000	None	None	250,000	None	40,000	None	None
Tennessee	E. R. Manning	700,000	None	None	700,000	Unknown	None	None	None
**Texas	R. L. Lewis	1,739,845	None	113,000	1,626,845	None	None	None	0 **
Utah	G. M. Jones	700,000	None	None	700,000	None	None	None	None
Vermont	F. E. Aldrich	225,200	None	None	225,200	None	None	None	None
Virginia	J. P. Bassett	1,360,000	5,000	5,000	1,300,000	None	50,000	None	None
Washington	F. G. Bentley	690,000	None	None	690,000	None	None	None	95,000
W. Virginia	J. S. Jones	355,537	128,000	None	213,278	14,259	None	None	None
Wisconsin	J. R. Schultz	740,000	None	470,000	270,000	None	None	None	470,000
Wyoming	D. G. Diller	1,063,425	None	None	1,063,425	None	None	None	None
	TOTALS	36,796,496	376,300	968,135	26,065,613	2,085,126	3,412,934	3,888,388	2,965,000

* Classified by Indiana as "Intermediate type mix (dense graded)" - includes Asphaltic Concrete, hot asphalt and cold mix cold laid mixtures.

** Texas uses Standard Asphalt Concrete Pavement as base under Portland Cement Concrete Pavement.

BITUMINOUS BOUND BASE COURSES
PRACTICE IN UNITED STATES
ALL STATES REPORTING
(ALASKA ONLY STATE NOT USING THIS TYPE CONSTRUCTION)

1968



COMBINED TOTAL ALL TYPES = 36,796,496 TONS

- PENETRATION MACADAM -

PENETRATION MACADAM

State	Bit. Matr. Type	Bit. Matr. Grade	Coarse Aggregate Type	Coarse Aggregate Processing	Coarse Aggregate Acceptance	Gradation	Residual Asph. Content	Field Control	Construction Method	Thickness	Avg. Bid Price	Comments
New Jersey	Ac.	85-100	Stone	Crushed & screened								
Ohio	Tar	RT 11&12	Stone slag	Crushed & screened	Los Angeles & soundness	SPR #3 with #8 choke Gradation only requirem't	6%	Thickness smoothness roller Wt. rolling pattern Ambient Temp. of 40°F+ No frozen subgrade	Result Require pneumatic, tandem & 3-wheel rollers	3 in. to 10 in. 3 in. Max. per lift	$6/ton	Equivalent Ratio (granular vs. black base 1:1.5) General experience is good Used Const. prior to 1968 with no recent changes
Rhode Island			Grav. stone	Crushed & screened		Required						No detail
Virginia	No detail											No detail
W. Virginia	No detail											No detail

For further information concerning Penetration Macadam see Appendix "A"

- MIXED-IN-PLACE -

MIXED-IN-PLACE

	Materials and Quality Control							Mix Design Methods and Criteria
State	Bit. Matr.	Coarse Aggr.	Coarse Aggr. Processing	Coarse Aggr. Quality	Fine Aggr.	Fine Aggr. Processing	Fine Aggr. Quality	Stability Requirement
Alabama	No Detail							
Arizona	MC-250 MC-800	Gravel stone	Crushed screened	Los Angeles Plasticity Index		Unwashed	Sand equivalent	Gradation and experience with other mixes
Illinois	Emul. Asph. SS-1 MWS-150 MWS-300	Gravel, stone, slag or blends	Screened	Los Angeles, soundness	None used	None used	None used	Gradation, asphalt content, coating
Maine	Emulsified Asphalt	Grav. Aggr.	Crushed & proportioned	Deleterious limit requirement on all Aggr.			Deleterious limit	Gradation
Minnesota	AC-1 200/300				Natural sand	Unwashed	Uniformity	
Nebraska	SMC 3				Natural soil with blends of fine Aggr.	Unwashed	Uniformity	No stability specified. Hubbard Field used for control purposes
No. Carolina	Used only on 15 miles of beach area. No technical data included with this report							
So. Carolina	RC-3000				Natural sand			Visual inspection for proper asphalt content
Texas	MC-3							Developing procedure
Wisconsin	SC-800 SS-1	Gravel stone	Crushed & screened	Los Angeles, soundness				Gradation only

MIXED-IN-PLACE - Specifications and Construction Practices

State	Gradation	Typical Residual Asph. Content, % of Mixture	Field Control	Construction Methods: Max. Thickness Per Lift	Construction Methods: Placing Equipment	Construction Methods: Roller Types
Alabama	No Detail					
Arizona	See Gradation table	4 - 5	Thickness specified, smoothness of ±3/16 in., roller weight and rolling pattern required		Grader	Pneumatic and tandem
Illinois	See Gradation table	2.5 - 4.0	Density, thickness, smoothness and roller weight are required	4 in.	Grader, paver or spreader box	Pneumatic, tandem or 3-wheel steel tired rollers. Vibratory may be approved. Tandem finish required for subbase under rigid pavements
Maine	See Gradation table	4.5	Density, smoothness & thickness	2½ in.	Paver or grader	Self-propelled steel, vibratory or pneumatic to achieve densities required
Minnesota	No specification	5.0	Density 100% of One Pt., thickness requirement ±½ in., smoothness 0.05 ft. from grade	No requirement	Grader	Pneumatic tired required, steel tired permitted
Nebraska	See Gradation table	6.0 +	Thorough compaction, roller weight & roller pattern specified	5 in.	Grader	Pneumatic and tandem
So. Carolina	No Gradation specified		Thickness requirement only	6 in.		Pneumatic and tandem
Texas	See Gradation table	4 - 6½				Pneumatic, tandem & 3-wheel
Wisconsin	See Gradation table	3 - 4	Density 95% T-99, 6 to 10-ton rollers, thickness & smoothness requirements	Not applicable	Not applicable	Contractor's option. Finish with tandem or 3-axle

MIXED-IN-PLACE - Specifications and Construction Practices (Continued)

State	Temperatures of Mixtures: At Plant	Temperatures of Mixtures: At Paver	Environmental Limitations: Ambient Temp.	Environmental Limitations: Substrata Temp.	Environmental Limitations: Permit Frozen Subgrade	Environmental Limitations: Season Limits	Environmental Limitations: Disposition of Mix Rained Out or Delayed	Overall Thickness Black Bases	Placing Bit. Base Direct on Subgrade	Describe Experience	Thick. Ratio Granular vs Black Base
Alabama	- -	- -	- -	- -	- -	- -	- -	- -	- -	- -	- -
Arizona	No requirement		$70^{o}F$		No			2 in. to 4 in.	No		2:1
Illinois	Varies with bituminous material		$+40^{o}F$	* $+50^{o}F$ 4 in. below Surf.	* No	* Apr. 15 to Sep. 15	Aerate and use	6 in.+	Yes	Satisfactory See Note	1.2:1 to 1.8:1
Maine			$+50^{o}F$		No	May 1 to Oct. 1		2 in.	No	None	
Minnesota	No requirement	No requirement	$50^{o}F+$		No	$33^{o}F+$ Ambient Temp.	Not specified	1½ in. to approx. 14 in.	Sometimes	Limited to date, some problems when first layer displacement	1.5:1
Nebraska			$60^{o}F+$		No			5 in.	Placed directly on sand subgrade	Good experience	
So. Carolina			$50^{o}F+$					4 in.	Yes		
Texas	Selected by Engr. $350^{o}F$ Max.	Plant $\pm 20^{o}F$	$50^{o}F$ if not falling or $40^{o}F$ & rising		Engr's judgment	None	Rejected		No, usually on subbase or lime treated subgrade	Satisfactory results to date	
Wisconsin			$+50^{o}F$		No	None	Reprocessed	2½ in. to 5 in.	No		

* Illinois: For subbase and shoulders, frozen subgrade not permitted, no substrata temperature specified, no seasonal limitations

MIXED-IN-PLACE - General

State	Avg. Bid Price/Ton	Comments on Performance	Remarks
Alabama	- -	No detail	State has no consolidated record to break down for this report
Arizona	$2.50	Construction prior to 1968 Satisfactory performance No recent changes	Black base is mixture of asphalt and aggregate base course. At this time a method of mix design is not used for black bases. Although bituminous treated bases are designed, as such, the aggregate is normally produced at the same source as the mineral aggregate for asphalt concrete. There is a complete asphalt concrete design on each source and this data is considered in making recommendations for the bituminous treated base.
Illinois	Not readily available	Construction prior to 1968 Satisfactory performance No recent changes	Marshall stability is not used for design of bituminous stabilized subbases and shoulders. Mixtures for base courses are designed with Marshall stabilities ranging from 900 to 1900 with low stability mixes used for local roads. We have been experimenting with a gyratory compactor for Approx. 2 years but have not yet chosen to use it for mix design. Gradation and a specified asphalt content based on sufficient aggregate coating are the only requirements for all mixes except base course mixtures that are designed by Marshall procedure. Sometimes difficult to obtain minimum density in first lift when placed directly on subgrade.
Maine	$8.00	Construction prior to 1968 Satisfactory performance	
Minnesota	$.60 per sq. yd. Inc. bitumen	Black bases were built prior to 1968 with satisfactory performance. Some recent changes have been made.	
Nebraska	$3.50 includes asphalt oil	Black bases were built prior to 1968 with satisfactory performance and no recent changes	
So. Carolina	$7.00	Black bases built prior to 1968 with satisfactory performance, no recent changes	
Texas		Construction prior to 1968 Satisfactory performance	Procedures for design and control of black base mixtures are being developed using air voids ratio. Method described in TP8-69E. Unconfined compression used in conjunction with triaxial to evaluate strength. With black base generally being utilized lower in the base and pavement structure the more rigid design and control measures specified for standard asphaltic concrete are

MIXED-IN-PLACE - General (Continued)

State	Avg. Bid Price/Ton	Comments on Performance	Remarks
Texas (Cont'd)			not deemed necessary. Control by gradation and road density being considered.
Wisconsin	$3.25	Black bases built prior to 1968 with satisfactory performance and no recent changes	

SPECIFICATIONS AND CONSTRUCTION PRACTICES - Gradation Table

MIXED IN PLACE	Sieve Size - % Passing													
	1½ in.	1 in.	3/4 in.	1/2 in.	3/8 in.	1/4 in.	#4	#8	#10	#16	#40	#50	#100	#200
Arizona		100	90-100			45-75								0-10
Illinois (sometimes altered)	100	90-100		60-90			35-55			10-40				4-12
Maine		100	90-100				45-65	32-52				10-22		2-8
Nebraska			100									60-100	20-80	12-32
Oklahoma														10-50
South Carolina - No gradation specified														
Texas - variable														
Wisconsin		100			50-85		35-65		25-50		10-30			3-10

- COARSE AGGREGATE TYPE HOT PLANT MIXED BASES -

COARSE AGGREGATE TYPE HOT PLANT MIXED BASES

	Materials and Quality Control							Mix Design Methods and Criteria
State	Bit. Matr.	Coarse Aggr.	Coarse Aggr. Processing	Coarse Aggr. Quality	Fine Aggr.	Fine Aggr. Processing	Fine Aggr. Quality	Stability Requirement
Alabama	No detail							
Arizona	AC 60/70 85/100	Gravel and crushed stone	Crushed and screened	Los Angeles, plasticity index	Natural, stone sand	Unwashed natural	Uniformity and sand equivalent	Gradation and experience with other mixes
Arkansas	AC 60/70	Crushed grav. & cr. stone	Crushed, screened & scalped only	Los Angeles	Natural	Unwashed	No report	Gradation is only requirement
California	AC 85/100 through 200/300	Gravel	Crushed, screened & proportioned	Los Angeles, CKE factor (absorptive factor) & crushed particle count	Crushed	Unwashed	Sand Equiv. & CKE factor (absorptive factor)	Hveem stability 35 Min., air voids 4 - 6%
Colorado	AC 120/150	Grav., stone, slag or blends	Crushed screened scalped and proportioned	Los Angeles	Natural sand, stone sand screenings or blends	Washed unwashed	Fineness modulus & sand equivalent	Air voids 3-5%, voids filled with AC 80-85%, Hveem stability 30-45, cohesiometer 150-500, unconfined compression strength 200-400 psi
Connecticut	AC 85/100	Gravel and cr. stone	Crushed, screened & proportioned	Los Angeles, soundness	Natural, stone sand or blends	Washed unwashed	Uniformity	Bitumen content requirement
Delaware	AC 85/100	Stone	Crushed screened	Los Angeles	Stone sand screenings	Unwashed	Uniformity	Gradation is only requirement along with AC content
District of Columbia	AC 85/100	Gravel stone	Crushed screened proportioned	Los Angeles, soundness	Natural, stone sand screenings or blends	Washed unwashed	Soundness, clay lumps, uniformity, Fin. Modulus & sand equiv. for information	3/4 in. Max. size aggr. Marshall stability 750 Min., flow 8-16, air voids 3-8, % voids filled with AC 65-75, also gradation requirement

COARSE AGGREGATE TYPE HOT PLANT MIXED BASES (Continued)

	Materials and Quality Control							Mix Design Methods and Criteria
State	Bit. Matr.	Coarse Aggr.	Coarse Aggr. Processing	Coarse Aggr. Quality	Fine Aggr.	Fine Aggr. Processing	Fine Aggr. Quality	Stability Requirement
Georgia	AC 85/100 60/70	Grav., stone slag or blends	Crushed screened proportioned	Los Angeles, soundness, detrimental substances	Natural stone sand screenings or blends	Washed unwashed	Uniformity	Marshall stability 1800 Min., flow 8-16, air voids 3-6, % voids filled with AC 65-75
Hawaii	AC 60/70	Stone	Crushed screened	Los Angeles	Stone sand screenings	Unwashed	Sand equivalent	Hveem stability 35 Min., cohesiometer 300 Min., air voids 5-10%, % voids filled with AC 75, CKE - K_c & K_f 17 Max., sand equivalent 50 Min.
Idaho	AC 85/100	Gravel stone slag	Crushed proportioned	Los Angeles & other	Natural stone sand screenings or blends	Unwashed	Sand equivalent	Hveem stability 30 Min., air voids 3-8
Illinois	MC-800 MC-3000 AC-200/300 AC-150/200 AC-120/150 AC-100/120	Gravel stone, slag or blends	Screened, cr. mat'l commonly used, req'd only on high stability designs	Los Angeles, soundness				Gradation, asphalt content, coating
Indiana	AP 3 & 5 AE 60, 90, 150	Grav., stone slag or blends	As necessary to meet specs	Los Angeles, Soundness, Class A or B	Natural stone sand or blends	As necessary to meet specs	Fineness modulus	Gradation requirement, Hveem stability may be required
Iowa	AC 85/100 120/150	Gravel stone or blends	Crushed screened scalped & proportioned	Los Angeles, Soundness P.I.	Natural, stone sand or blends	Washed unwashed	P.I.	Gradation, fixed AC content 4.0% 2 classes of base - Class I Min. 70% crushed stone, Class II no Min. crushed material

COARSE AGGREGATE TYPE HOT PLANT MIXED BASES (Continued)

State	Materials and Quality Control							Mix Design Methods and Criteria
	Bit. Matr.	Coarse Aggr.	Coarse Aggr. Processing	Coarse Aggr. Quality	Fine Aggr.	Fine Aggr. Processing	Fine Aggr. Quality	Stability Requirement
Kansas	AC-5 85/100	Cr. stone, crushed or uncrushed gravel or blends	Crushed screened proportioned	Los Ang. 45% soundness .85 (freeze thaw) deleterious, absorption	Chat natural sand	Crushed screened	P.I.	Marshall stability 800-3000, flow 5-15, air voids 1-5, % voids filled w/AC 70-85, gradation, P.I.
Kentucky	PAC-5 85/100	No gravel is used but is permitted, stone, slag	Crushed screened	Los Angeles, Soundness, shale and deleterious	Natural, stone sand, slag or blends	Washed unwashed	Fineness modulus sand equivalent	Marshall stability 1100-1500, flow 12-15, air voids 4-6, gradations
Louisiana	AC 60/70	Gravel	Crushed as needed, screened proportioned	Los Angeles, Soundness				Marshall stability, flow, air voids, voids filled with AC
Maine	AC 85/100	Gravel stone or blends	Crushed screened proportioned	Deleterious	Natural, stone sand or blends	Unwashed	Deleterious, sand equivalent	Hveem, air voids, % voids filled with AC
Mass.	AC 85/100	Stone	Crushed screened	Los Angeles	Natural, stone sand or blends	Washed unwashed	Gradation	By gradation only
Maryland	AC 85/100	Grav., stone slag or blends	Crushed screened proportioned	Los Angeles, Soundness	Blends of natural & stone sand	Washed unwashed	Uniformity	Marshall stability, flow, air voids, % voids filled with AC, also specify voids mineral aggregate
Michigan	AC 120/150	Gravel	Scalped only	Deval 40%				
Minnesota	AC-1 200/300	Grav., stone or blends	Crushed screened proportioned	Los Angeles 35 Max., spall 5% Max.	Natural	Unwashed	Uniformity	Gradation only

COARSE AGGREGATE TYPE HOT PLANT MIXED BASES (Continued)

State	Materials and Quality Control							Mix Design Methods and Criteria
	Bit. Matr.	Coarse Aggr.	Coarse Aggr. Processing	Coarse Aggr. Quality	Fine Aggr.	Fine Aggr. Processing	Fine Aggr. Quality	Stability Requirement
Mississippi	AC 60/70	Gravel stone, slag or blends	Crushed screened proportioned when crushed 85% fractured Ret. #4 sieve	Los Angeles 40 Max. weight 70#/cf Min.	Natural stone sand or blends	Unwashed	Uniformity P.I. Max. 6	Marshall stability 1600 (75 blows @ 140°F), flow 16 Max., air voids 5-7%, % voids filled with AC 50-70, also controlled by gradation
Missouri	AC 60/150	Stone	Crushed screened	Los Angeles Deleterious	Natural sand	Washed	Uniformity	Unconfined compression, requirements not specified, % asphalt
Montana	AC 85/100 100/120	Gravel seldom slag or blends	Crushed screened		Natural		Uniformity gradation	Marshall stability, flow, air voids, % voids filled with AC
Nebraska	AC 85/100	Gravel	Screened proportioned	Soundness, gradation	Natural			No specification requirement, Marshall used only for control
Nevada	AC 60/70 200/300	Gravel	Crushed screened proportioned	Los Ang., Cr. particles, P.I. strip, swell				Hveem stability 30-37 Min., air voids 3-5
New Hampshire	AC 85/100	Gravel stone	Crushed screened proportioned	Los Angeles, Soundness	Natural, stone sand or blends	Washed unwashed	Uniformity	
New Jersey	AC 85/100	Gravel stone	Crushed screened proportioned	Geology Sod. sulphate Deval wear	Natural, stone sand or blends	Washed unwashed	P.I., geology soundness hot mix formula	Marshall stability 1100-1500, flow 6-18, air voids 3-7%, gradation and bitumen content
New Mexico	AC 85/100	Grav., stone blends of ea. also Caliche	Crushed	Los Angeles, Soundness	Natural	Unwashed		Unconfined compressive strength psi, air voids, % voids filled with AC, P.I. limit of 6 or less

COARSE AGGREGATE TYPE HOT PLANT MIXED BASES (Continued)

	Materials and Quality Control							Mix Design Methods and Criteria
State	Bit. Matr.	Coarse Aggr.	Coarse Aggr. Processing	Coarse Aggr. Quality	Fine Aggr.	Fine Aggr. Processing	Fine Aggr. Quality	Stability Requirement
New York	AC 85/100	Gravel stone, slag	Crushed	Soundness Deval	Natural, stone sand or blend	Unwashed		By gradation only
N. Carolina	AC AP-3	Stone	Crushed screened proportioned	Los Angeles Grading A 50% Sod. sulfate 5 cycles -15%		Screened	Gradation	Marshall stability 800, flow 7-14, air voids 3-8; Hubbard Field 800 Min. on aggr. passing #10 sieve using 2 in. specimen, 90% voids filled with AC. Also gradation and AC content
North Dakota	AC 85/100 120/150 SC-3000	Bank run gravel including	Crushed	Los Ang. -50 gradation & other physical properties	Natural	Unwashed		Marshall stability 400 Min., flow 8-18, air voids 3-5%, 8% Max. clay content, 12% Max. shale & soft rock content
Ohio	AC 85/100 Tar 11, 12 optional	Grav., stone, slag, blends of the 3	Crushed screened proportioned	Los Angeles, Soundness, deleterious	Natural, stone sand & blends also slag	Washed unwashed	Uniformity & soundness	Gradation is only requirement
Oklahoma	AC-3 85/100	Grav., stone or blends also use mine chat	Crushed screened scalped proportioned	Los Angeles sand equivalent	Natural manufactured	Screened	Job mix formula sand equivalent	Hveem stability 35 Min., air voids not more than 8%
Oregon	AC 60/70	Gravel, stone or blends	Crushed screened proportioned	Los Angeles, Soundness	Natural manufactured	Washed unwashed	Sand equivalent & uniformity	Hveem stability 30 Min., cohesiometer 150 Min., air voids 10% Max., unconfined compression 150 psi Min., AASHO T-165 70% Ret. strength
Pennsylvania	AC-2000 RT-12 & 14	Gravel stone slag	Crushed screened proportioned	Los Angeles, Soundness	Natural	Washed		Marshall stability +700, flow 6-16, % voids filled with AC 60-85%
Puerto Rico		Gravel stone	Crushed	Los Angeles, Soundness	Natural, stone sand	Washed	Uniformity	

COARSE AGGREGATE TYPE HOT PLANT MIXED BASES (Continued)

	Materials and Quality Control							Mix Design Methods and Criteria
State	Bit. Matr.	Coarse Aggr.	Coarse Aggr. Processing	Coarse Aggr. Quality	Fine Aggr.	Fine Aggr. Processing	Fine Aggr. Quality	Stability Requirement
Rhode Island	AC 85/100	Gravel, stone or blends	Crushed	Los Angeles	Natural, stone sand or blend	Washed unwashed	Uniformity	Marshall stability 750+, flow, air voids 3-8%, gradation factor in design
So. Carolina	AC 85/100	Gravel stone	Crushed, proportioned, uncrushed grav.	Los Angeles	Natural, stone sand	Washed unwashed	Uniformity	Marshall stability 1200-3000, flow 6-12
South Dakota	AC 85/100 120/150	Gravel	Crushed 2 bin separation	Los Angeles 50% Max., P.I. 6 Max.	Natural	Screened		Marshall stability, flow 8-18, air voids 3-5%
Tennessee	AC 85/100	Grav., stone, slag or blends	Crushed screened proportioned	Los Angeles, soundness	Natural, stone sand or blends	Washed unwashed	Uniformity	1 in. Max. size Marshall stability, flow, air voids, % voids filled with AC
Texas	AC 10/20	Gravel stone, slag or blends	Crushed screened	Los Angeles, Soundness	Natural, stone sand or blend field sand			Hveem stability 30
Utah	AC 85/100	Gravel slag	Crushed screened proportioned	Los Angeles, Soundness	Natural, stone sand or blend	Unwashed		Marshall stability, flow, air voids, unconfined compression
Vermont	AC 100/120	Gravel stone	Crushed screened	Los Angeles, Deval	Natural, stone sand or blend	Unwashed		By gradation only
Virginia	AP-3 85/100	Gravel stone	Crushed screened proportioned	Los Ang. 45% Mg soundness 20%@ 5 cycles	Natural stone sand	Washed unwashed	Uniformity & sand equivalent	Gradation only
Washington	AC 85/100	Combined grav., stone	Cr'd, scr'd scalped proportioned pit run	Los Angeles degradation factor	Natural, stone sand or blend	Washed unwashed	Uniformity & sand equivalent	Hveem stability 20 Min., cohesiometer 50, also use modified immersion/compression with Hveem specimen 70% Min.

COARSE AGGREGATE TYPE HOT PLANT MIXED BASES (Continued)

	Materials and Quality Control							Mix Design Methods and Criteria
State	Bit. Matr.	Coarse Aggr.	Coarse Aggr. Processing	Coarse Aggr. Quality	Fine Aggr.	Fine Aggr. Processing	Fine Aggr. Quality	Stability Requirement
W. Virginia	No detail							
Wisconsin	AC 85/100 120/150	Gravel stone	Crushed screened	Los Angeles, Soundness	Natural	Screening		Gradation methods used only
Wyoming	AC 120/150 200/300	Gravel stone	Crushed screened	Los Angeles, Soundness P.I. -6	Natural, stone sand or blend	Unwashed	Sand equivalent	Marshall stability 1000 Min., immersion compression ratio 50, uncovered base (temporary surf.), 35 covered base

COARSE AGGREGATE TYPE HOT PLANT MIXED BASES - Specifications and Construction Practices

State	Gradation	Typical Residual Asph. Content, % of Mixture	Field Control	Construction Methods: Max. Thickness Per Lift	Construction Methods: Placing Equipment	Construction Methods: Roller Types
Alabama	No detail					
Arizona	See grada. table	4½ - 5½	92% Max. theoretical density, thickness requirement, smoothness ±¼ in., roller weight and pattern specified	3 in.	Paver	Require both pneumatic roller & tandem roller
Arkansas	See grada. table	3.5	Density, thickness, smoothness, roller weight & pattern required	3 in.	Paver with electronic screed control	Breakdown steel-wheeled, intermediate pneumatic, final tandem
California	See grada. table	4½ - 5	Thickness 3 in., roller weight 12 tons, roller pattern also required	3 in.	Paver	3-wheel breakdown, pneumatic tired finish
Colorado	See grada. table	6	Density, thickness, smoothness and roller pattern required	3 in.	Not specified	Not specified
Connecticut	See grada. table	4 - 6	Density 90-98% theoretical, smoothness 3/8 in. in 10 ft., roller weight 10 ton Min., roller pattern sides to center & overlap	6 in.	Approved mechanical equipment	3 wheel, tandem and rubber tire
Delaware	See grada. table	2.0 - 4.0	Specify 8-ton roller	No limit	Paver for full width & belt feed widening	
District of Columbia	See grada. table	5.0	Density 94% of Marshall, thickness as per design, 8 ton Min. roller, roller pattern longitudinal lap from outside	4 in.	Self-propelled spreader-finisher	Tandem (2 or 3 axle) & pneumatic
Georgia	See grada. table	4.5 - 5.0	96% density, thickness, smoothness roller weight & pattern required	4 in.	Paver	10-12 ton 3-wheel, 50-80 psi pneumatic, 6-8 ton tandem

COARSE AGGREGATE TYPE HOT PLANT MIXED BASES - Specifications and Construction Practices (Continued)

State	Gradation	Typical Residual Asph. Content, % of Mixture	Field Control	Construction Methods: Max. Thickness Per Lift	Placing Equipment	Roller Types
Hawaii	See grada. table	3.8	90% density, thickness requirement combined with surfacing ±¼ in., smoothness requirement 3/16 in. in 10 ft.	4 in.	Paver	12 ton steel, pneumatic 2/2000# wheel load to 90 psi inflation
Idaho	See grada. table	5.5 - 6.0	Smoothness, roller weight & pattern required	0.4 ft.	Paver	Tandem, pneumatic, 3-wheel
Illinois	See grada. table	5 ± 1	Density, thickness, smoothness & roller weight are required	4 in.	Grader, paver or spreader box	Pneumatic, tandem, 3-wheel; tandem finish required for subbase under rigid pavement. Vibratory may be approved
Indiana	See grada. table	3 - 4.2	Density by Special Provision, thickness, smoothness, roller weight & pattern specified	Not to exceed 3 times the top size aggr.	Paver	2-axle tandem, 3-wheel, 3-axle tandem & pneumatic
Iowa	See grada. table	4.0	Density, thickness and smoothness requirements	None specified	Paver or grader	Both tandem and pneumatic
Kansas	See grada. table	6 - 8	100% of all tests ≥ 92% of Field Marshall density, 50% of all tests ≥ 94% of Field Marshall density, uniform thickness, smoothness Max. ±¼ in. in 10 ft., roller required to obtain density	2 in. - 3 in.	Paver	2-axle steel tandem 8-12 ton, 3-axle steel tandem not less than 12 ton, light self-propelled pneumatic gross weight between 8 & 25 tons
Kentucky	See grada. table	5.0	Thickness, smoothness, roller weight and roller pattern requirements	3 in.	Paver	10 ton 3 wheel, pneumatic, tandem
Louisiana	See grada. table	3 - 6	Density requirement	Contractor's option	Paver with or without elec. scrd. control	3-wheel, pneumatic, tandem

COARSE AGGREGATE TYPE HOT PLANT MIXED BASES - Specifications and Construction Practices (Continued)

State	Gradation	Typical Residual Asph. Content, % of Mixture	Field Control	Construction Methods		
				Max. Thickness Per Lift	Placing Equipment	Roller Types
Maine	See grada. table	5	Density, thickness, smoothness requirements	2½ in.	Paver	Self-propelled steel, vibratory or pneumatic to achieve densities req'd
Mass.	See grada. table	4 - 5	95% of Lab compacted density, 4 in. - 5 in. compacted thickness, smoothness 3/8 in. for 16 ft. straightedge 10 ft. for vertical curves, roller weight 240 lb/in. tread, roller pattern required	2 in.	Paver	Pneumatic tired, tandem, 3 wheel tandem steel tired rollers
Maryland	See grada. table	4 - 9	Density, smoothness requirements		Paver	Steel and pneumatic
Michigan	See grada. table	4 - 6	4 in. thickness, 10 ton roller weight	2 in.	Paver	Tandem and pneumatic
Minnesota	See grada. table	3.5 - 4.5	Density 95% of Marshall, thickness ±½ in. smoothness 0.05 ft. from grade	No Max. requirement	Paver	Pneumatic required steel permitted
Mississippi	See grada. table	3 - 8 with 5 avg.	Density, smoothness, roller weight and roller pattern requirements	Variable 4 in. Max.	Paver with automatic scr'd control	10 ton 3-wheel or 8-10 ton tandem, 12 ton pneumatic Avg contact 80 psi
Missouri	See grada. table	5.0	Density, thickness, roller weight requirements	4 in.	Paver	Pneumatic, 3 wheel, tandem
Montana	See grada. table	6 ±	Density, thickness, smoothness, roller weight and pattern requirements	Typical sect. with density control	Paver	Not less than 2 rollers, 1 pneumatic and 1 steel tired

COARSE AGGREGATE TYPE HOT PLANT MIXED BASES - Specifications and Construction Practices (Continued)

State	Gradation	Typical Residual Asph. Content, % of Mixture		Construction Methods		
				Max. Thickness Per Lift	Placing Equipment	Roller Types
Nebraska	See grada. table	4.0±	Density 90% of voidless mix, Approx. thickness specified, smoothness ±1/8 in. in 10 ft., roller weight required to obtain density, roller pattern required	3 in.	Paver	As necessary to obtain density
Nevada	See grada. table	4 - 8	Thickness, smoothness, roller weight & pattern requirements	4 in. compacted	Paver with automatic screed control	Pneumatic, 2 axle & 3 axle tandem
New Hampshire	See grada. table	4.3	Density until all roller marks removed, thickness & roller weight requirements, uniform rolling pattern required	4 in.	Paver	Breakdown 2 axle tandem, pneumatic 9 wheel-2000#/wheel, final roller-3 axle tandem, all steel rollers must weight 8 tons Min.
New Mexico	See grada. table	4 - 8	Density, thickness, smoothness, roller weight & pattern requirements	4 in.	Paver	Any type necessary to obtain density provided such equipment does not injure the asphalt treated base
New York	See grada. table	2.5 - 5.0	Thickness, smoothness, roller weight & pattern requirements	4 in.	Paver	3 wheel or tandem, pneumatic
North Carolina	See grada. table	4 ± 0.5	90% of Max. theoretical density, test grade each 25 ft. to ½ in. of required grade smoothness ±1/8 in. in 10 ft., roller weight & pattern required. Breakdown 3 wheel 10-12 ton, intermediate pneumatic 60-90 psi, finish tandem 8-12 ton	3 in. Max.	Paver	3 wheel 10-12 ton, tandem 8-12 ton, pneumatic 60-90 psi
North Dakota	See grada. table	5 - 7.5	Avg. of 5 tests = 95% of Marshall, no test below 93%, smoothness ±¼ in. in 10 ft., thickness on plan	Not specified -thin enough to obtain compaction	Paver	Permit all types except grid or sheepsfoot, to obtain density required

COARSE AGGREGATE TYPE HOT PLANT MIXED BASES - Specifications and Construction Practices (Continued)

State	Gradation	Typical Residual Asph. Content, % of Mixture	Field Control	Construction Methods: Max. Thickness Per Lift	Construction Methods: Placing Equipment	Construction Methods: Roller Types
Ohio	See grada. table	5	Thickness, smoothness, roller weight and roller pattern requirements	6 in.	To obtain desired result	Pneumatic, tandem steel wheel, tandem 3 wheel rollers
Oklahoma	See grada. table	4.3	95% lab compacted mixture, reasonable thickness conformity, smoothness 1/4 in. in 10 ft., roller weight 2 tons Min.		Paver	Pneumatic, tandem, 3 wheel
Oregon	See grada. table	3 - 6½	92% Min. density, smoothness .02in./ft., roller weight and pattern required to obtain end result	4 in.	To obtain end result	To obtain end result
Pennsylvania	See grada. table	4 - 5	90% of Marshall density, smoothness ±3/8 in., roller weight 60-95 psi, roller pattern required	5 in.	Paver	3 wheel, tandem 120#/lin. in., pneumatic 60-95 psi, intermediate pneumatic
Puerto Rico	See grada. table	3 - 6	Thickness 3-4 in., roller weight 8-18 tons	None		3 wheel, 2 axle tandem, 3 axle tandem
Rhode Island	See grada. table	3 - 6	Density, thickness & smoothness requirements	As specified	Paver	Tandem
South Carolina	See grada. table	4.0 - 5.5	Thickness, roller weight and roller pattern requirements	3 in.	Paver	3 wheel, pneumatic, tandem
South Dakota	See grada. table	6.5	95% of 50 blow Marshall density, smoothness requirement	3 in.	Paver	
Tennessee	See grada. table	4.0	Density, smoothness, roller weight requirements	3 in.	Paver, automatic controls	Pneumatic, tandem, 3-wheel
Texas	See grada. table	4 - 6½	Density, thickness, smoothness, roller weight & pattern requirements	Usually 7 in.		All three types specified

COARSE AGGREGATE TYPE HOT PLANT MIXED BASES - Specifications and Construction Practices (Continued)

State	Gradation	Typical Residual Asph. Content, % of Mixture	Field Control	Construction Methods		
				Max. Thickness Per Lift	Placing Equipment	Roller Types
Utah	See grada. table	5	Density 96% of Marshall, thickness requirement, smoothness 3/8 in. in 10 ft.	4 in.		
Vermont	See grada. table	2.5 - 3.5	Thickness, smoothness, roller weight & pattern requirements	2½ in.	Paver	2 axle tandem 8-10 ton, 3 axle tandem 12-20 ton
Virginia	See grada. table	4.5	Min. 90% density required	4 in.	Paver	Pneumatic, tandem & 3 wheel
Washington	See grada. table	3.5	80% theoretical Max. (Rice), thickness 0.3 ft. Min. original - 0.1 ft. leveling, smoothness ¼ in./10 ft.	Full depth	Optional	2 tandem, 1 pneumatic
W. Virginia	No detail					
Wisconsin	See grada. table	3½ - 4½	Smoothness 1/8 in./10 ft., roller weight 8-12 tons	4 in.	Paver	Contractor's option final roll w/tandem or 3 axle
Wyoming	See grada. table	4.5 - 5.5	Density 95%, thickness requirement		Pavers or other appr'vd laydown equip.	

COARSE AGGREGATE TYPE HOT PLANT MIXED BASES - Specifications and Construction Practices (Continued)

State	Temperatures of Mixtures		Environmental Limitations					Overall Thickness Black Bases	Placing Bit. Base Direct on Subgrade	Describe Experience	Thick. Ratio Granular vs Black Base
	At Plant	At Paver	Ambient Temp.	Substrata Temp.	Permit Frozen Subgrade	Season Limits	Disposition of Mix Rained Out or Delayed				
Alabama	No detail										
Arizona	Max. 350^oF	Min. 240^oF			No		Dispose	3 in. to 6 in.	No		2½:1
Arkansas	$285\text{-}325^oF$	Min. 275^oF	40^oF		No	Mar. 15- Dec. 15	Discretion of Engineer	8 in.	No		
California	Max. 325^oF	Min. 225^oF	40^oF+		Yes	None	No report	3 in.	Formerly but not at present		Varies with traffic
Colorado		Requirement	Requirement		No	None	No requirement	Variable	Sometimes	Depends on subgrade conditions & materials	4:1
Connecticut	$325^oF \pm 15^o$	260^oF	40^oF+			Apr. 1- Oct. 15	Depends on length of delay & mat'l Temp.	6 in.	Usually placed on other base material		
Delaware	$200\text{-}250^oF$	Not less than 20^o of plant Temp.	40^oMin.			Apr. 1- Nov. 15	Pay for acceptable mat'l in place	3 in. - 8 in.	Yes	Use of 2½ in. being discontinued	Select borrow 3.75:1 to 4.5:1
District of Columbia	$250\text{-}325^oF$	$250\text{-}325^oF$	35^oMin.		No	None	Rejected - disposal is contractor's responsibility	3 in. to 12 in.	No - usually on select soil	Satisfactory	Dense graded stone 2:1 select soil 2.7:1
Georgia	$\pm 15^oF$	$\pm 15^oF$	40^o & rising	40^oF	No	None		4 in. - 8 in.	Allowed	Satisfactory	1.5:1
Hawaii	320^oF Max.	250^oF Min.	50^oF					4 in. - 10 in.	Permitted on primed subgrade		1.75:1
Idaho	Vis. of AC		40^oF+	40^oF+	No	None	Wasted	0.4 ft.	Sometimes		1.75:1
Illinois	Varies with bituminous material		+40^oF	* +50^oF 4 in. below Surf.	* No	* Apr. 15- Sep. 15	Reject	6 in.+	Yes	Satisfactory See notes	1.4:1 to 3.3:1
Indiana	$270\text{-}300^oF$		+45^oF See note					By design	Special Provisions		
Iowa	310^oF Max.	225^oF Min.	40^oF		No	Nov. 15	Wasted	4 in. - 15 in.	Normally placed on soil cement or lime treated soil		AASHO Guide

* Illinois: For subbase and shoulders, frozen subgrade not permitted, no substrate temperature specified, no seasonal limitations.

COARSE AGGREGATE TYPE HOT PLANT MIXED BASES - Specifications and Construction Practices (Continued)

State	Temperatures of Mixtures		Environmental Limitations								
	At Plant	At Paver	Ambient Temp.	Substrata Temp.	Permit Frozen Subgrade	Season Limits	Disposition of Mix Rained Out or Delayed	Overall Thickness Black Bases	Placing Bit. Base Direct on Subgrade	Describe Experience	Thick. Ratio Granular vs Black Base
Kansas	275-325°F	250-325°F	40°F+		No	None	Not accepted - contractor's responsibility	4 in.-14½ in.	Yes	Good	1:1 to 1.26:1
Kentucky	240-325°F	225-325°F	40°Min.		No	Apr. 1-Nov. 15	Wasted	2 in. - 9 in.	No		2:1 for special conditions
Louisiana	275-350°F		40°F+				Accept mix in transit before rain	6 in.	No - Have plans for trial		
Maine	300°F+	290°F+	40°F+		No	May 1-Oct. 1	Not placed	5 in.	No	Good performance	
Mass.	275-325°F	275°F	40°F+		No	Apr. - Nov.	Discarded	4 in. - 5 in.	Yes	Works well, Dept. experimenting with Deep Lift	12 in. Grav. Borrow Min. 3:1
Maryland	To give viscosity of 75-150 SSF	225°F+	40°F			Mar. 1-Nov. 15		3 in. - 9 in.	Sand subgrade only		2:1
Michigan	275-325°F	275-325°F	40°F+			May 15-Oct. 30	Engineer's judgment	4 in.	No	Placed on prepared gravel	1.75:1
Minnesota	325° Max.	No requirement	33°Min.		No	None	Not specified	1½ in. to approx. 14 in.	Sometimes	Limited, some problems 1st layer displacement	2:1
Mississippi	250-350°F	225-350°F	40°F+		Yes	None	Protected, held in truck until after rain. Surface moisture removed. If within Temp. range may be placed at contractor's risk	Var. to 8 in.	No	Layer thickness up to 4 in. permitted	3.4:1 clay gravel seldom used in base
Missouri	275-350°F		40°F	32° Min. for 36 hours	No		Wasted	4 in. - 12 in.	Not usually	Varied	1.5:1 with 3 in. or 15% reduction in thickness

COARSE AGGREGATE TYPE HOT PLANT MIXED BASES - Specifications and Construction Practices (Continued)

State	Temperatures of Mixtures		Environmental Limitations					Overall Thickness Black Bases	Placing Bit. Base Direct on Subgrade	Describe Experience	Thick. Ratio Granular vs Black Base
	At Plant	At Paver	Ambient Temp.	Substrata Temp.	Permit Frozen Subgrade	Season Limits	Disposition of Mix Rained Out or Delayed				
Montana	Asphalt viscosity Temp. range		40°F & rising		No	Apr. 1-Nov. 1 or special approval	Rejected if unacceptable	Variable	Yes	Recent and experimental	Approx. 2.125:1
Nebraska	250-350°F		35°F+		No			Up to 6 in.	Sometimes placed directly on subgrade	No serious difficulty to date	2:1 to 3.14:1
Nevada	225-325°F	225° Min.	40° Min.				Engineer's prerogative	7 in. to date	No		2.27:1 to 3.78:1
New Hampshire	275°F Avg.	250°F Min.	40° & rising in shade		No	None		Up to 6 in. in 2 lifts	New construction Class "A" Surf. treatment-Prime		About 2:1
New Jersey	275-325°F		40° Min.		No		Decision of Engineer	2 in. - 6 in.	No		About 2:1
New Mexico	250°F	230°F	40° &		No	None	Disposed of	4 in. - 8 in.	No		3:1
New York		225-300°F		45°F	No	None	Discarded	4 in. - 8 in.	No	Placed only on granular subbase	
North Carolina	250-300°F, usually 280° ±15°	250-300°F, usually 280°±15-25°	40°F in shade		No	None	Wasted	Structural requirement, normal Max. 8 in., Max. used 11 in.	Yes	Clean and to grade	2.14:1
North Dakota	300°F	225°F	35° Min.		No	None	Wasted	2 in. - 5 in.	Yes	Less cracking when directly on subgrade	3:1
Ohio	250-300°F	250-300°F	40°F		No		Not used	3 in. - 10 in.	Some	Generally good	2.5:1
Oklahoma	250-325°F	225-300°F	35°F & rising	32°F+	No	None	Discarded	7 in. - 10 in.	Yes	Good	1.25:1
Oregon	250-325°F	250-300°F	40°F & rising		No		Rejected	3 in. - 12 in.	No		1.5:1 to 1.8:1

COARSE AGGREGATE TYPE HOT PLANT MIXED BASES - Specifications and Construction Practices (Continued)

State	Temperatures of Mixtures: At Plant	Temperatures of Mixtures: At Paver	Environmental Limitations: Ambient Temp.	Environmental Limitations: Substrata Temp.	Environmental Limitations: Permit Frozen Subgrade	Environmental Limitations: Season Limits	Environmental Limitations: Disposition of Mix Rained Out or Delayed	Overall Thickness Black Bases	Placing Bit. Base Direct on Subgrade	Describe Experience	Thick. Ratio Granular vs Black Base
Pennsylvania	150-280 centistokes viscosity	-15°F mixing Temp.	+40°F	+40°F	No	Apr. 1-Oct. 1	Rejected by temperature	Varies on soil design requirement	No		3.5:1
Puerto Rico	300°F Max.	225°F Min.			No	None	Not accepted	4 in.+	Sometimes	Recently placed	2:1
Rhode Island	Specified	Specified	Specified				Meet specs	As required	Yes		
South Carolina	250-325°F	250-325°F	37°F		No		Not accepted if chilled	5 in. - 7 in.	Yes, but not necessarily	Satisfactory	2.1:1
South Dakota	285°F	270-275°F	35°F		No	May 1-Nov. 15		3 in. - 10 in.	Yes	First lift on subgrade should not be less than 2 in. compacted thickness to achieve desired density & facilitate compaction, thinner lifts tend to displace under rollers	3:1
Tennessee	250-325°F	-25°F	40° Min.		No	March-Dec.	Variable	7 in. - 10 in.	No		
Texas	Max. 350°F	Plant Temp. ±25°	50° if not falling or 40° & rising		Engr's judgment		Rejected	7 in. - 11 in.	No, usually on subbase or lime treated subgrade	Results to date have been satisfactory	
Utah	150-300CS viscosity specified		50° Min.	50°F+	No		Not used	Varies	Sometimes	Generally excellent	3:1
Vermont	225°F ±20°		40° Min.			Nov. 1		3 in. - 5 in.	Yes	Satisfactory	
Virginia	225-300°F	225-300°F			No	None	Rejected	4 in. - 8 in.	Yes		2:1
Washington			40° Min.		No	By written order		6 in.	Yes		1.4:1
W. Virginia	No record	No record	No record		No record		No record	No record	No record	No record	

COARSE AGGREGATE TYPE HOT PLANT MIXED BASES - Specifications and Construction Practices (Continued)

State	Temperatures of Mixtures		Environmental Limitations					Overall Thickness Black Bases	Placing Bit. Base Direct on Subgrade	Describe Experience	Thick. Ratio Granular vs Black Base
	At Plant	At Paver	Ambient Temp.	Substrata Temp.	Permit Frozen Subgrade	Season Limits	Disposition of Mix Rained Out or Delayed				
Wisconsin	±15° of specified	±20° of specified	+40°F		No	May 1-Oct. 15	Remove and dispose	2 in. - 6 in.	No		
Wyoming	Not specified at present but will be at the plant Penetration grade asphalts to achieve viscosity of 75-150 SSF		40° Min.		No			Have laid 2-12 in. normal 4-8 in.	Yes	Limited, results have been good	2:1 to 3:1

COARSE AGGREGATE TYPE HOT PLANT MIXED BASES - General

State	Avg. Bid Price /Ton in place	Comments on Performance and Remarks
Alabama	No report	State has no consolidated record to break down for this report
Arizona	$3.86	Used prior to 1968 with satisfactory performance and no recent changes. Black base is a mixture of asphalt and aggregate base course. At this time a method of mix design is not used for black bases. Although bituminous treated bases are not designed, as such, the aggregate is normally produced at the same source as the mineral aggregate for asphalt concrete. There is a complete asphalt concrete design on each source and this data is considered in making recommendations for the bituminous treated base.
Arkansas	$5.65	Used prior to 1968 with satisfactory performance and no recent changes
California	$7.50	Black bases built prior to 1968. The California Division of Highways uses a base course of asphalt concrete in some forms of construction. This base course is 3 in. thick and has a maximum sieve size of 1-½ in. It is designed and tested in the same manner as our Type A and Type B surfacing courses. The so-called asphalt concrete base is part of a 7 in. asphalt concrete section laid over aggregate base and subbase. In the last few years we have been using our standard Type A or Type B surfacing gradings (3/4 in. or 1/2 in. maximum) for the base layer because of continuing difficulties with the large aggregate during laydown. At commercial plants in urban areas it is sometimes less costly to use the same mix for both surface and base to avoid changing plant screens. The use of this type of section using large aggregate in the base was fairly common in the State during the 1920-1930 period. The asphalt concrete was laid directly on the basement soil. Under increased heavy traffic loads these pavements began to fail and construction involving a cement treated base with a 3 in. or 4 in. wearing course of asphalt concrete became common. Only recently have we started to lay a 7 in. asphalt concrete pavement over an untreated rock base. We have not had any recent experience with other bituminous treated bases although some experimental sections, placed by other agencies, are under observation.
Colorado	No record	Have built black bases prior to 1968 with satisfactory performance and no recent changes
Connecticut	$10.00	Black bases built prior to 1968, satisfactory performance. Has been recent change - size of coarse aggregate reduced. Pre-mix base has proved very satisfactory.
Delaware	$7.75	Black bases built prior to 1968, satisfactory performance. The use of coarse aggregate type base with 2½ in. is being discontinued in favor of 1¼ in. max. size. 2½ in. coarse aggregate is open allowing water to pass to subgrade creating grade trouble.
District of Columbia	Approx. $13 small jobs 1000 tons±	Black bases built prior to 1968, satisfactory performance but still being evaluated, no recent changes - no basis for change at this time
Georgia	$7.44	Black bases built prior to 1968, satisfactory performance, have made recent changes to require void limits of 3-6%

COARSE AGGREGATE TYPE HOT PLANT MIXED BASES - General (Continued)

State	Avg. Bid Price /Ton in place	Comments on Performance and Remarks
Hawaii	$12.70	Black bases were not constructed prior to 1968, no recent changes made
Idaho	$2.64 to 4.65 range, $3.25 Avg.	Black bases built prior to 1968, satisfactory performance. Recently raised AC content to reduce stripping and increased rolling pattern to 10 coverages minimum to obtain greater density.
Illinois	$9.90	Black bases built prior to 1968, satisfactory results, recent changes are that density requirements for stabilized subbases and shoulders were recently increased to make the mixes less permeable. Marshall stability is not used for design of bituminous stabilized subbases and shoulders. Mixtures for base courses are designed with Marshall stabilities ranging from 900 to 1900 with the low stability mixes used for local roads. We have been experimenting with a gyratory compactor for approximately 2 years but have not yet chosen to use if for mix design. Gradation and a specified asphalt content based on sufficient aggregate coating are the only requirements for all mixes except base course mixtures that are designed by Marshall procedure. Sometimes difficult to obtain minimum density in first lift when placed directly on subgrade.
Indiana		Black bases built prior to 1968, satisfactory performance, no recent changes. Dry surface, weather conditions permit proper handling and finishing
Iowa	Class I $6.14 " II 4.72	Black bases built prior to 1968, satisfactory performance, minor changes have been made to adjust to new methods, equipment, etc. Iowa hot black bases are similar to very lean asphalt concrete mixtures of the dense graded type.
Kansas	$5.90	Black bases built prior to 1968, satisfactory performance, no recent changes. Construction of the state system is now nearly limited to hot plant mix, machine laid bases
Kentucky	$8.05	Black bases built prior to 1968, satisfactory performance, no recent changes
Louisiana	$6.00	Black bases are relatively new. Only two projects have been let and are not yet under construction; therefore, we have no experience with black base construction.
Maine	$8.50	Black bases built prior to 1968, satisfactory performance, have dropped fine aggregate plant-mixed base ("stabilized" base) and use Bit. Conc. base. Design Dept. has better values for B.C. base and have had fewer problems than with stabilized base.
Mass.	$8.00±	Black bases built prior to 1968, satisfactory performance, recent changes - experimental with one lift, one lift of 4½ in. has been made on two projects with success.
Maryland	$7.80	Black bases built prior to 1968, satisfactory performance, no recent changes

COARSE AGGREGATE TYPE HOT PLANT MIXED BASES - General (Continued)

State	Avg. Bid Price /Ton in Place	Comments on Performance and Remarks
Michigan	$5.80	Black bases not built prior to 1968
Minnesota	$4.28	Black bases built prior to 1968, satisfactory performance, change made - the hot mix base will be used to greater extent in the future
Mississippi	$7.18	Black bases built prior to 1968, satisfactory performance, no recent changes
Missouri	$7.45	Black bases built prior to 1968, satisfactory performance, no recent changes
Montana	$3.29	Black bases built prior to 1968, satisfactory performance, recent change - quality improvement based on previous experience, incorporated density requirement and wear test in new specifications
Nebraska	$6.90 w/AC	Some black bases built prior to 1968, satisfactory performance, no recent changes
Nevada	$4.51	Black bases built prior to 1968, satisfactory performance, recent changes - under certain conditions the crushed particles and grading requirements were relaxed, to lower unit prices with no undue loss in quality
N. Hampshire	$8.65	Black bases built prior to 1968, satisfactory performance, no recent changes. May go to thick lift type construction
New Jersey	50¢/s.y./in.	Black bases built prior to 1968, satisfactory performance, no recent changes
New Mexico	$3.62	Black bases built prior to 1968, satisfactory performance, no recent changes. Overall performance very satisfactory
New York	$11.50±	Black bases built prior to 1968, satisfactory performance, no recent changes
N. Carolina	$8.24	Black bases built prior to 1968, very good performance, no recent changes
North Dakota	$5.00	Black bases built prior to 1968, performance variable - some satisfactory, some not. Recent changes - when we started the black base program the mixes were generally too dry and we attempted to use them as wearing courses for too long. Since we increased bitumen content and placed second stage sooner, problem has largely been overcome. Our practice (stage construction) is to place a hot mix type base course as second stage construction. The first stage is the cold mix type which is placed in the grading stage. Then the hot mix type is placed when needed to renovate the project to a new condition. This may be required from 1 to 7 years after the 1st stage has been placed.
Ohio	$8.27	Black bases built prior to 1968, satisfactory performance, recent changes - design range for bitumen content changed from 3-5% to 4-7% and additional gradation control limits added to assure a more uniform, higher quality material.

State	Avg. Bid Price /Ton in Place	Comments on Performance and Remarks
Oklahoma	$4.80	Black bases built prior to 1968, very good performance, recent changes have been made. There was a change made in the gradation of the CABB. This change gave us a more dense base, also less porous. This has proved to be very satisfactory.
Oregon	$6.60	Black bases built prior to 1968, satisfactory performance, no recent changes
Pennsylvania	$2.50/sq. yd.	Black bases built prior to 1968, satisfactory performance, no recent changes
Puerto Rico*	$14.00	Black bases built prior to 1968, satisfactory performance, no recent changes. A black base is now being included in our primary routes and expressways when a flexible type pavement is used. In lower order roads a black base may be used instead of crushed stone if economically feasible.
Rhode Island		Black bases built prior to 1968, satisfactory performance
S. Carolina	$4.47	Black bases built prior to 1968, satisfactory performance, no recent changes
South Dakota		Black bases built prior to 1968, satisfactory performance, no recent changes. Performance of black bases have been good to date. The equivalency ratio to granular base has allowed a reduction in thickness of pavement structure and conservation of material. Black base furnishes undiminished support during the spring thaw period. Less transverse cracking of the pavement surface is apparent on most of the black base sections placed to date.
Tennessee	$5.75	Black bases built prior to 1968, satisfactory performance, no recent changes
Texas	$5.52	Black bases built prior to 1968, satisfactory performance. Procedures for design and control of black base mixtures are being developed using air voids ratio. Method described in TP8-69E. Unconfined compression used in conjunction with triaxial to evaluate strength. With black base generally being utilized lower in the base and pavement structure, the more rigid design and control measures specified for standard asphaltic concrete are not deemed necessary. Control by gradation and road density being considered.
Utah	$3 Approx.	Black bases built prior to 1968, satisfactory performance, no recent changes
Vermont	$8.25	Black bases built prior to 1968, satisfactory performance, some proposed changes to "tighten" the mix, also plan to reduce the maximum stone size and eliminate some of the skip gradings.
Virginia	$5.00	Black bases built prior to 1968, satisfactory performance, recent changes - some aggregate sources produced mixes that are too coarse and open graded, lowered top size from 2 in. to 1½ in. and slightly changed other screen controls to increase fines to densify mix.

COARSE AGGREGATE TYPE HOT PLANT MIXED BASES - General (Continued)

State	Avg. Bid Price /Ton in Place	Comments on Performance and Remarks
Washington	$5.19	Black bases built prior to 1968, satisfactory performance, first used in 1965. Experience generally limited to Puget Sound gravels. Has been used primarily as working platform and to weatherproof subgrade.
W. Virginia		No details. Record system completely different from that contemplated by questionnaire.
Wisconsin	$3.50	Black bases built prior to 1968, satisfactory performance, no recent changes
Wyoming	$2.096	Black bases built prior to 1968, satisfactory performance, recent changes - with a relaxation of specifications, the price of base has been reduced. Base no longer has the same specifications as plant mix pavement. Structural credit is now given for "black" bases.

COARSE AGGREGATE TYPE HOT PLANT MIXED BASES

SPECIFICATIONS AND CONSTRUCTION PRACTICES - Gradation Table

	Sieve Size - % Passing																					
	2½ in.	2 in.	1½ in.	1¼ in.	1 in.	3/4 in.	5/8 in.	1/2 in.	3/8 in.	1/4 in.	#4	#6	#8	#10	#16	#20	#30	#40	#50	#80	#100	#200
Arizona					100	90-100				45-75												0-10
Arkansas			100			60-100					25-60							10-35				3-12
California				100	95-100	80-95			50-65		35-50						12-25					2-7
Colorado						100					30-60		25-50									5-12
Connecticut			100			62-80			44-65		34-52		24-40				9-25					2-6
Delaware	100	90-100	60-90		40-75			15-40			5-25		0-15									
Dist. (Cl. A)			100		90-100	70-95		50-80			30-55			20-42				8-22		3-12		1-8
of Col. (Cl. B)					100	90-100			60-85		45-65			30-50				10-25		3-15		2-8
Georgia			100		90-100			50-80					25-45									0-10
Hawaii				100	85-100			60-85			40-55		30-40				12-21				7-14	1-8
Idaho						100			70-90		48-70		50-55		20-40		15-30		10-23			4-10
Ill. (sometimes altered)			100		90-100			60-90			35-55				10-40							4-12
Indiana (No. 5)			100		80-94	65-85		45-70	30-60		20-35		15-30		10-23		5-15		2-10		0-6	0-2
(also have grada. Nos 4, 53B & 73B)																						
Iowa					100	90-100			60-94		40-80		30-65				15-40					3-10
Kansas (BC-4)			100		85-100				65-99				35-80				20-49					7-15
(also have BC-1, ACB-2, ACB-3)																						
Kentucky			100		85-100			50-80			30-50		25-45		15-35				5-20		3-10	
Louisana			100		80-100	70-95		55-85			35-60			20-45				10-30		5-25		2-10
Maine		100	90-100			50-80			35-65		25-50		20-40		13-33				6-24		4-16	1-8
Massachusetts		100	90-100		65-90	55-80		40-65			20-45			15-30				5-15				0-4
Maryland		100	90-100			66-100			48-90		30-76		22-64		17-50				8-27			0-10
(3 overlapping bands within)																						
Michigan					100				60-85				25-55									0-15
Minnesota						100	95-100		65-95					35-65				10-35				1-7
Mississippi			100		80-100			60-100			34-75			24-60				10-44		4-26		3-14
Missouri			100					60-90			35-65			25-45				10-30				5-12
Montana			100		90-100						35-65											3-10
Nebraska					100	95-100								25-45					13-23			5-11
Nevada					100	90-100			55-85		35-65				15-40							3-9

COARSE AGGREGATE TYPE HOT PLANT MIXED BASES

SPECIFICATIONS AND CONSTRUCTION PRACTICES - Gradation Table (Continued)

	Sieve Size - % Passing																					
	2½ in.	2 in.	1½ in.	1¼ in.	1 in.	3/4 in.	5/8 in.	1/2 in.	3/8 in.	1/4 in.	#4	#6	#8	#10	#16	#20	#30	#40	#50	#80	#100	#200
N. H. (desired grada.)			100	95-100	85	72		60	50		36			23		15		10		6		2
New Jersey		100	90-100			60-100					25-60		20-50						8-30			4-12
New Mexico					100	80-100					30-60			20-45								4-12
New York		100	75-100		55-80			23-42		5-20		2-15										
N. Carolina		100	90-100			65-80					30-45			20-35								0-5
North Dakota						100		70-100			40-76		30-65		22-55		15-47		10-35		6-24	4-20
Ohio		100			75-100			50-85			25-60		15-45		10-35				3-18			1-7
Oklahoma			100			60-100			40-75		30-60			20-43				8-26				2-10
Oregon					100																	
Pennsylvania		100	95-100			52-100			36-70				16-38				8-24		6-18		4-10	
Puerto Rico			100		70-100	50-80			25-50		10-30		5-20									0-4
Rhode Island			100			60-80			35-60				20-35						3-12			0-4
" (Pl. Mix Macadam)			100	90-100	35-70	0-25		0-5														
S. Carolina			100		80-100			45-60			25-40		15-30									
South Dakota					100	80-100					40-70			27-53				10-32				3-10
Tenn. (Master Limits)			100			65-90					30-35		20-45				8-25				1-12	0-7
" (Desired Limits)		100	75-100			45-70			30-55		20-40		10-30				5-20					0-8
Texas - Variable																						
Utah					100			70-100			41-68				21-41				10-27			4-13
Vermont		100			55-75			25-55			5-25			0-10								
"			100		65-85	55-75		40-57			18-30			5-15								2-6
Virginia			100			72-87					35-50		28-38									2-9
Washington		100						56-100		40-78				22-57				8-32				
W. Virginia - Not recorded																						3-12
Wisconsin					100				50-85		35-65		25-55						8-25			3-15
Wyoming ("C" Grading)			100		95-100						40-65		30-55									3-12
" ("W" Grading)			100		95-100						45-65		33-53									

- COARSE AGGREGATE TYPE COLD PLANT MIXED BASES -

COARSE AGGREGATE TYPE COLD PLANT MIXED BASES

	Materials and Quality Control							Mix Design Methods and Criteria
State	Bit. Matr.	Coarse Aggr.	Coarse Aggr. Processing	Coarse Aggr. Quality	Fine Aggr.	Fine Aggr. Processing	Fine Aggr. Quality	Stability Requirements
Arkansas	Emulsion SS-1	Gravel stone	Crushed screened scalped proportioned	Los Angeles	Natural	Unwashed	Uniformity	Gradation is only requirement
Illinois	Emulsions SS-1 MWS-150 MWS-300	Gravel stone slag or blends	Screened	Los Angeles, Soundness	Natural manufactured			Gradation, asphalt content and coating
Indiana	AE 90, 150 & 200	Gravel stone, slag or blends	As Necessary to meet specs	Los Angeles, Soundness	Natural stone sand or blends	As necessary to meet specs	Fineness modulus	Use Hveem but not always required
Iowa	Emulsion SS-1	Gravel stone or blends	Crushed screened scalped	Los Angeles, P.I.	Natural sand	Washed unwashed	P.I. only	Gradation & fixed AC content 3.0%
Maine	AES 3 (M)	Gravel	Crushed proportioned	Deleterious	Natural sand		Deleterious, sand equiv.	
Maryland	Emulsion AEBM	Stone slag	Crushed screened proportioned	Los Angeles, Soundness	Stone sand screenings	Unwashed	Uniformity	Gradation only requirement
Minnesota	AE, SS-1 or CSS-1h	Grav., stone or blends	Crushed screened proportioned					Gradation only
New York	MC-250	Gravel stone slag	Crushed screened scalped proportioned	Soundness, P.I.				Unconfined compression Min. 200, extrusion Min. 200, water absorption less than 2%

COARSE AGGREGATE TYPE COLD PLANT MIXED BASES (Continued)

	Materials and Quality Control							Mix Design Methods and Criteria
State	Bit. Matr.	Coarse Aggr.	Coarse Aggr. Processing	Coarse Aggr. Quality	Fine Aggr.	Fine Aggr. Processing	Fine Aggr. Quality	Stability Requirements
North Dakota	SMK, MC & RC, 70, 250 & 800	Bank run grav. incl. fines	Crushed	Los Ang. -50 gradation & other physical properties	Bank run	Unwashed		Require complete coating of aggr. & Engr judgment on how mix handles and lays, 8% Max. clay content, 12% Max. shale & soft rock content
Pennsylvania	Cutback MC-250 or MC-800 AC Tar RT-9 & 6 Emul. -5 & 6 (CMS&SS)	Gravel stone slag	Crushed screened proportioned	Los Angeles, Soundness	Natural	Washed		Gradation, A/C Min. 2.8 residual
Tennessee	Emulsion AE-3	Stone slag or blends	Crushed screened proportioned	Los Angeles, Soundness	Natural, stone sand or blends	Washed unwashed	Uniformity	
W. Virginia	No detail							

COARSE AGGREGATE TYPE COLD PLANT MIXED BASES - Specifications and Construction Practices

State	Gradation	Typical Residual Asph. Content, % of Mixture	Field Control	Construction Methods: Max. Thickness Per Lift	Construction Methods: Placing Equipment	Construction Methods: Roller Types
Arkansas	See grada. table	2.0	Density, thickness and smoothness requirements	6 in.	Paver with electronic screed control	Steel wheel, pneumatic, tandem
Illinois	See grada. table	2.5 - 4.0	Density, thickness, smoothness & roller weight requirements	4 in.	Grader, paver or spreader box	Pneumatic, tandem, 3 wheel, vibratory may be approved; tandem finish req'd for subgrade under rigid pavements
Indiana	See grada. table	2.5 - 5.0	Density by Special Provisions, thickness smoothness, roller weight and roller pattern specified	Not to exceed 3 times the top size aggregate	Pavers required and specification details	Two axle tandem, 3-wheel 3-axle tandem and pneumatic
Iowa	See grada. table	3.0	Density, thickness and smoothness requirements	None specified	Paver grader	Pneumatic, tandem & sheepsfoot
Maine	See grada. table	5	Thickness, smoothness and roller weight requirements	2½ in.	Paver or grader	Self-propelled steel, vibratory or pneumatic, to achieve densities req'd
Maryland	See grada. table	3.0 - 3.5	Density and smoothness requirements		Approved equipment	Steel and pneumatic tired
Minnesota	See grada. table	2.0 - 4.0	Density 100% of One Pt., thickness ± ½ in., smoothness 0.05 ft. from grade		Grader or paver	
New York	See grada. table	2.5 - 4.0	Thickness, smoothness, roller weight and pattern requirements		Approved spreaders & pavers	3 wheel or tandem, pneumatic
North Dakota	See grada. table	3 - 5	Avg. of 5 tests = 95% Marshall, no test below 93%, thickness on plan, smoothness ±¼ in. in 10 ft.	Not specified -thin enough to obtain compaction	Grader or pavers	Permit all types except grid or sheepsfoot to obtain density required

COARSE AGGREGATE TYPE COLD PLANT MIXED BASES - Specifications and Construction Practices (Continued)

State	Gradation	Typical Residual Asph. Content, % of Mixture	Field Control	Construction Methods		
				Max. Thickness Per Lift	Placing Equipment	Roller Types
Pennsylvania	See grada. table	3.5	Density 100% T-99, variable thickness, smoothness ±½ in., roller weight and pattern required	6 in.	Approved paver	3-wheel, tandem (120#/ lin. inch), pneumatic (60-95 psi), intermediate pneumatic
Tennessee	See grada. table	3.0	Smoothness and roller weight requirements	3½ in.	Paver automatic screed controls	Pneumatic, tandem and 3-wheel
W. Virginia	No detail					

State	Temperatures of Mixtures: At Plant	Temperatures of Mixtures: At Paver	Environmental Limitations: Ambient Temp.	Environmental Limitations: Substrata Temp.	Environmental Limitations: Permit Frozen Subgrade	Environmental Limitations: Season Limits	Disposition of Mix Rained Out or Delayed	Overall Thickness Black Bases	Placing Bit. Base Direct on Subgrade	Describe Experience	Thick. Ratio Granular vs Black Base
Arkansas						Apr. 1-first frost in Nov.	Left to discretion of Engineer	8 in.	Yes		
Illinois	Varies with bit. mat'l		+40°F	* +50°F 4 in. below Surf.	* No	* Apr. 15-Sep. 15	Aerate & use	6 in.+	Yes	Satisfactory See Note	1.2:1 to 1.8:1
Indiana	200-260°F		45°F+					By design	Special Provisions		AASHO Guide
Iowa					No	Nov. 15	Wasted	Min. 4 in. Max. 15 in. to date	Can be, normally on soil cement or lime treated soil		
Maine			50°F+		No	May 1-Oct. 1	Not placed	3 in.	No		
Maryland			40°F			Mar. 1-Nov. 15		3 in. - 9 in.	No		2:1
Minnesota			33° Min.		No	None	Not specified	1½ in. to approx. 14 in.	Sometimes	Limited, some problems 1st layer displacement	1.25:1 to 1.5:1
New York			45°F+		No	5/15-11/15	Allow for curing	4 in.	No	Placed only on granular subbase	
North Dakota			35° Min.		No	None	Dried & used	6 in.	Yes	Less cracking when directly on subgrade	2:1

* Illinois: For subbase and shoulders, frozen subgrade not permitted, no substrata temperature specified, no seasonal limitations.

COARSE AGGREGATE TYPE COLD PLANT MIXED BASES - Specifications and Construction Practices (Continued)

State	Temperatures of Mixtures		Environmental Limitations					Overall Thickness Black Bases	Placing Bit. Base Direct on Subgrade	Describe Experience	Thick. Ratio Granular vs Black Base
	At Plant	At Paver	Ambient Temp.	Substrata Temp.	Permit Frozen Subgrade	Season Limits	Disposition of Mix Rained Out or Delayed				
Pennsylvania	150-280 centistokes viscosity	-15°F mixing Temp.	+40°F		No	Apr. 1 or 15- Oct. 1 or 15	Temperature rejection	Varies with soil design requirement	No		2:1
Tennessee					No	March to Dec.	Variable	7 in. - 10 in.	No		

COARSE AGGREGATE TYPE COLD PLANT MIXED BASES

SPECIFICATIONS AND CONSTRUCTION PRACTICES - Gradation Table

	Sieve Size - % Passing																
	2½ in.	2 in.	1½ in.	1 in.	3/4 in.	1/2 in.	3/8 in.	1/4 in.	#4	#8	#10	#16	#30	#40	#50	#100	#200
Arkansas			100		60-100				25-60					10-35			3-12
Illinois (sometimes altered)			100	90-100		60-90			35-55			10-40					4-12
Indiana (No. 5) (also have grada. Nos. 2, 4, 53-B & 73-B)			100	85-98	60-85	30-60	10-35		0-10	0-5							0-2
Iowa (either hot or cold)				100	90-100		67-100		47-80	36-65			17-40				3-10
Maine				100	90-100				45-65	32-52					10-22		2-8
Maryland		100	90-100		68-86		55-70		45-60	35-51		27-42			13-27		5-12
Minnesota				100	90-100		50-90		35-80		20-60			10-35			1-7
New York		100						30-65									0-10
North Dakota					100	70-100			40-76	30-65		22-55	15-47		10-35	6-24	4-20
Pennsylvania		100	95-100		52-100		36-70			16-38		10-30	8-24			0-2	
Tennessee (Master Range)		100	60-95		0-20		0-5		0-2								
(Desired Range)	95-100		30-70		0-15		0-3										
West Virginia - Not recorded																	
Intermediate Aggregate Type (dense graded)																	
Indiana				100	85-96	56-87			33-58				14-29				0-5

COARSE AGGREGATE TYPE COLD PLANT MIXED BASES - General

State	Avg. Bid Price /Ton in Place	Comments on Performance and Remarks
Arkansas		Used prior to 1968 with satisfactory performance and no recent changes
Illinois		Black bases built prior to 1968, satisfactory performance, no recent changes. Marshall stability is not used for design of bituminous stabilized subbases and shoulders. Mixtures for base courses are designed with Marshall stabilities ranging from 900 to 1900 with the low stability mixes used for local roads. We have been experimenting with a gyratory compactor for approximately 2 years but have not yet chosen to use it for mix design. Gradation and a specified asphalt content based on sufficient aggregate coating are the only requirements for all mixes except base course mixtures that are designed by Marshall procedure. Sometimes difficult to obtain minimum density in first lift when placed directly on subgrade.
Indiana		Black bases built prior to 1968, satisfactory performance, no recent changes. Dry surface and weather conditions which permit proper handling and finishing.
Iowa	$2.88	Black bases built prior to 1968, satisfactory performance, minor changes only
Maine	$7.00	Black bases built from 1964, satisfactory performance, have dropped fine aggr. plant-mixed base ("stabilized" base) and use Bit. Conc. base. Design Dept. has better values for B.C. base and had a few reports of problems with "Stabilized".
Maryland	$5.60	Black bases built prior to 1968, satisfactory performance, no recent changes
Minnesota	$3.06	Black bases built prior to 1968, satisfactory performance, change made - the hot mix base will be used to greater extent in the future
New York	$6.00	Black bases built prior to 1968, satisfactory performance, no recent changes
North Dakota	$3.00	Black bases built prior to 1968, performance variable - some satisfactory, some not; recent changes - when we started the black base program the mixes were generally too dry and we attempted to use them as wearing courses for too long. Since we increased bitumen content and placed second stage sooner, problem has largely been overcome. Our practice (stage construction) is to place a hot mi type base course as second stage construction. The first stage is the cold mix type which is placed in the grading stage. Then the hot mix type is placed when needed to renovate the project to a new condition. This may require from 1 to 7 years after the first stage has been placed.
Pennsylvania	$2.69/s.y.	Black bases built prior to 1968, satisfactory performance, no recent changes
Tennessee	None	Black bases built prior to 1968, satisfactory performance, no recent changes
W. Virginia	No detail	Record system completely different from that contemplated by questionnaire

- FINE AGGREGATE TYPE PLANT MIXED BASES - HOT & COLD -

FINE AGGREGATE TYPE PLANT MIXED BASES - HOT AND COLD

	Materials and Quality Control							Mix Design Methods and Criteria
State	Bit. Matr.	Coarse Aggr.	Coarse Aggr. Processing	Coarse Aggr. Quality	Fine Aggr.	Fine Aggr. Processing	Fine Aggr. Quality	Stability Requirements
Arkansas	AC 60/70	None			Natural	Unwashed	Uniformity	Gradation is only requirement
Delaware	AC 85/100	Bank run (20% stone screenings)	Scalped proportioned		Blends of sand & stone screenings	Unwashed	Uniformity	Marshall stability 500# Min., asphalt content
Florida	AC 85/100	None			Sand, limerock screenings shell or blend	Washed unwashed	Uniformity, clay content limitation	Hubbard Field 800 & 1200 lbs.
Georgia					Natural	Unwashed	Uniformity	Hubbard Field 300#, 7 day absorption 4%
Indiana	AP 3 & 5 AE 60, 90 150	Grav., stone slag or blend Also use Class A or B	As necessary to meet specs	Los Angeles, Soundness, Class A or B	Natural, stone sand or blends	Processed as necessary to meet specs	Fineness modulus	Use Hveem stability but not always required, gradation used in design methods
Maryland	AC 85/100				Natural, stone sand & blends	Unwashed		Marshall stability, flow, air voids, % voids filled with AC
Montana	As specified				Natural, stone sand & blends		Gradation	
Nebraska	AC 120/150				Natural with limestone dust	Unwashed	Uniformity	Use Hubbard Field for control only, no specification
North Carolina	AC AP-3	Screenings & blends of sand and screenings	Crushed screened proportioned	Los Angeles Grading A-50% solium sulfate 5 cycles -15%	Sand, stone sand & blends	Washed screened	Conform with approved gradation	Marshall stability 500-600, Hubbard Field 800# Min. on aggr. passing #10 sieve using 2 in. Hubbard Field test
Oklahoma	AC-3 85/100 MC-800			Los Angeles, sand equivalent	Natural, stone sand, Mine Chat & blends	Washed crushed blended	Job mix formula sand equiv.	Hveem stability 20 min., air voids not more than 18%

FINE AGGREGATE TYPE PLANT MIXED BASES - HOT AND COLD (Continued)

	Materials and Quality Control							Mix Design Methods and Criteria
State	Bit. Matr.	Coarse Aggr.	Coarse Aggr. Processing	Coarse Aggr. Quality	Fine Aggr.	Fine Aggr. Processing	Fine Aggr. Quality	Stability Requirements
Rhode Island	AC 85/100	Gravel stone & blend	Crushed		Natural, stone sand & blends	Washed unwashed	Uniformity	Marshall stability 1000, flow 8-16, air voids 3-5%, gradation also used
South Carolina	AC 85/100				Natural stone sand	Unwashed	Uniformity %-#200 sieve	Marshall stability 100-500, flow 5-9
South Dakota	85/100				Natural or blends	Screened	P.I. Max. 6	No requirement. Asphalt content used to give 75% of original stability after 24 hours in water bath at 140°F
Virginia	AP-3 85/100	Gravel stone	Crushed screened proportioned	Los Angeles $MgSO_4$ 24% loss @ 5 cycles	Natural stone sand	Washed unwashed	Uniformity & sand equivalent	Marshall stability Min. 400, flow -1 in.

FINE AGGREGATE TYPE PLANT MIXED BASES - HOT AND COLD - Specifications and Construction Practices

State	Gradation	Typical Residual Asph. Content, % of Mixture	Field Control	Construction Methods		
				Max. Thickness Per Lift	Placing Equipment	Roller Types
Arkansas	See grada. table	7.0	Density, thickness, smoothness, roller weight & pattern required	2 in.	Paver with electronic screed control	Steel wheel, pneumatic & tamdem rollers required
Delaware	See grada. table	5.0 - 7.0	Density 90% Marshall, smoothness ¼ in. in 16 ft., 8 ton roller required	3 in.	Paver	
Florida	See grada. table	As specified ±0.4	Thickness ± ½ in., smoothness ± ½ in., roller weight & pattern specified	3 in.	Paver grader	Tandem 5-12 tons & 8-12 tons, pneumatic tired 6-10 tons
Georgia	See grada. table	3.5 - 4.5	Density 95%, variable thickness, smoothness & roller weight requirements	6 in.		
Indiana	See grada. table	2.5 - 4.5	Density by Special Provisions, thickness, smoothness, roller weight and roller pattern specified	Not to exceed 3 times the top size aggr.	Paver	Pneumatic & steel tired with specified weights
Maryland	See grada. table	4 - 6	Density & smoothness requirements		Paver	Steel and pneumatic tired
Montana	See grada. table		Density, thickness, smoothness, roller weight and pattern requirements	As shown on plan	Paver	Not less than 2 rollers, 1 pneumatic and 1 steel tired
Nebraska	See grada. table	6.0	Density 92% of Lab. H.F. 2 in., approx. thickness specified, smoothness 1/8 in. Max. in 10 ft., roller weight required to obtain density, roller pattern required	2 in.	Paver	As necessary to obtain density

FINE AGGREGATE TYPE PLANT MIXED BASES - HOT AND COLD - Specifications and Construction Practices (Continued)

State	Gradation	Typical Residual Asph. Content, % of Mixture	Field Control	Construction Methods		
				Max. Thickness Per Lift	Placing Equipment	Roller Types
North Carolina	See grada. table	4 - 8	90% of max. theoretical density. Test each 25 ft. to ½ in. of required. Smoothness ± 1/8 in., roller weight & pattern required	3 in. unless under special provisions	Paver	Breakdown 3-wheel 10-12 ton Intermediate: pneumatic 60-90 psi Finish tandem: 8-12 ton
Oklahoma	See grada. table	5.5 & 4-6	With hot type 95% Lab compacted, thickness reasonable conformity, smoothness ¼ in. in 10 ft., roller weight 2 ton Min; with soil asphalt type no density requirement, 6 in. Min. thickness, smoothness & roller weight same		Paver	Pneumatic, tandem, 3 wheel; on soil asphalt sheepsfoot also required
Rhode Island	See grada. table	7-9, 4-6, 6.5-8	Density, thickness & smoothness requirements	As specified	Paver	Tandems
South Carolina	See grada. table	4.0 - 5.5	Thickness, roller weight and roller pattern requirements	3 in.	Paver	Pneumatic & tandem
South Dakota	See grada. table	7.5	94% of 50 blow Marshall	3 in.	Paver	Approved rollers
Virginia	See grada. table	5.0	Min. 85% density required	2 in.	Paver	Pneumatic, tandem & 3 wheel

FINE AGGREGATE TYPE PLANT MIXED BASES - HOT AND COLD - Specifications and Construction Practices (Continued)

State	Temperatures of Mixtures		Environmental Limitations					Overall Thickness Black Bases	Placing Bit. Base Direct on Subgrade	Describe Experience	Thick. Ratio Granular vs Black Base
	At Plant	At Paver	Ambient Temp.	Substrata Temp.	Permit Frozen Subgrade	Season Limits	Disposition of Mix Rained Out or Delayed				
Arkansas	285-325°F	Min. 275°F	40°F		No	Mar. 15-Dec. 15	Discretion of Engineer	6 in.	No		
Delaware	225-275°F	225-275°F	40° Min.			Apr. 1-Nov. 15	Pay for acceptable mat'l in place	3 in. - 6 in.			2.5:1
Florida	285-360°F	250-350°F	40°F+					6-10 in.	Yes	See Note	
Georgia	±15°F			50°F+	No	None		6 in.	Yes	Satisfactory	
Maryland	Viscosity 75-150 SSF	225°F+	40°F			Mar. 1-Nov. 15		3 in. - 9 in.	No		2:1
Montana	Asphalt viscosity Temp. range		40°F & rising			Apr. 1-Nov. 1	Rejected if unacceptable	Variable			
Nebraska	250-350°F		35°F+		No			Up to 6 in.	Sometimes	No serious difficulty	
North Carolina	250-300°F usually 280° ±15°	250-300°F usually 280°±15-20°	40° in shade		No	None	Wasted	Normal Max. 8 in., Max. used 11 in.	Yes	Clean and to grade	2.14:1
Oklahoma	250-325°F Soil asphalt 125-225°F	180-300°F	Hot type 35°F & rising, soil asphalt 50°F Min.	32°F	No	Hot type= none; Soil asph. Apr. 1-Nov. 1	Discarded	Hot type 8-12 in., soil asphalt 6-9 in.	Yes	Good	1:1
Rhode Island	Requirement	Requirement	Req'mnt				As covered by specifications				

FINE AGGREGATE TYPE PLANT MIXED BASES - HOT AND COLD - Specifications and Construction Practices (Continued)

State	Temperatures of Mixtures		Environmental Limitations					Overall Thickness Black Bases	Placing Bit. Base Direct on Subgrade	Describe Experience	Thick. Ratio Granular vs Black Base
	At Plant	At Paver	Ambient Temp.	Substrata Temp.	Permit Frozen Subgrade	Season Limits	Disposition of Mix Rained Out or Delayed				
South Carolina	250-325°F	250-325°F	37°F		No		Not accepted if chilled	4 in. - 8 in.	Yes, but not necessarily	Satisfactory	1.8:1
South Dakota	285°F	270-275°F	35°F		No	May 1-Nov. 15		2 in. - 6 in.	Yes	1st lift on subgrade should be 2 in. Min. compacted to achieve density & facilitate compaction, thinner lifts tend to displace under rollers	2:1
Virginia	225-300°F	225-300°F			No	None	Rejected		Yes		

FINE AGGREGATE TYPE HOT PLANT MIXED BASES

SPECIFICATIONS AND CONSTRUCTION PRACTICES - Gradation Table

	Sieve Size - % Passing															
	1½ in.	1 in.	3/4 in.	5/8 in.	1/2 in.	3/8 in.	#4	#8	#10	#16	#30	#40	#50	#80	#100	#200
Arkansas					100											5-20
Colorado		100						20-85								5-15
Delaware				100												
Florida					100											0-12
Kansas (BC-1)		100				65-99		40-75			20-45					7-15
Maryland																0-12
Montana	100	90-100					35-65									3-10
Nebraska			100										35-75			7-16
N. Carolina					100		95-100		80-100			50-95		5-30		0-8
Oklahoma		100					75-100		55-100			25-85				5-20
Rhode Island							100	95-100		85-98	70-95		40-75		20-40	8-16
S. Carolina - No gradation specified																
South Dakota - Gradation modified to meet local available sources																
Virginia		100	90-100				70-100	50-95			25-65		12-40		1-20	0-10
FINE AGGREGATE TYPE COLD PLANT MIXED BASES																
Georgia *		100							80-100							0-25

* Clay = 0-16

FINE AGGREGATE TYPE PLANT MIXED BASES - HOT AND COLD - General

State	Avg. Bid Price /Ton in Place	Comments on Performance and Remarks
Arkansas	$5.88	Black bases built prior to 1968, satisfactory performance, no recent changes
Delaware	$6.35	Black bases built prior to 1968, satisfactory performance, no recent changes
Florida	$4.00	Black bases built prior to 1968, satisfactory performance, no recent changes. First layer (3 in. thick) placed on subgrade using a paver. Sometimes paver and trucks disturb subgrade.
Georgia	Generally bid by sq. yd.	Black bases built prior to 1968, satisfactory performance, no recent changes. Avg. bid price for soil & mixing is $.26/s.y. & Avg. bid price for Bit. mat'l is $.15/gal
Maryland	$6.40	Black bases built prior to 1968, satisfactory performance, no recent changes
Montana	$3.29	Black bases built prior to 1968, satisfactory performance. Quality improvement based on previous experience incorporated density requirement and wear test in new specifications
Nebraska	$6.90	Black bases built prior to 1968, satisfactory performance, no recent changes
N. Carolina	$8.24	Black bases built prior to 1968, satisfactory performance, no recent changes
Oklahoma	$4.30 hot type 2.30 soil asphalt	Both types have been built prior to 1968, satisfactory performance, no recent changes
Rhode Island		Black bases built prior to 1968, satisfactory performance
S. Carolina	$3.10	Black bases built prior to 1968, satisfactory performance, no recent changes
South Dakota		Black bases built prior to 1968, satisfactory performance, no recent changes. Performance of black bases have been good to date. The equivalency ratio to granular base has allowed a reduction in thickness of pavement structure and conservation of material. Black base furnishes undiminished support during the spring thaw period. Less transverse cracking of the pavement surface is apparent on most of the black base sections placed to date.
Virginia	$5.00	Black bases built prior to 1968, satisfactory performance, recent changes - some aggr. sources produced mixes that are too coarse and open graded, lowered top size from 2 in. to 1½ in. and slightly changed other screen controls to increase fines to densify mix.

APPENDIX A

TABLE 1

MATERIALS SPECIFICATIONS FOR BITUMINOUS MACADAM SURFACE COURSE

State[1,2]	Bituminous Material	Application No.	Application Rate (gal/sq yd)	Max. L. A. Wear[3] (%)
Conn.	85-100	1	1.75-2	35
Del.	85-100 RC-1	1	1.8 per 4" depth	45
		2	0.4	
Ga.	AC-6,7,8 AE-1 RC-12	1	1.3-1.65	
		2	0.4-0.6	45 Class A 60 Class B
		3	0.2-0.4	
Haw.	50-60 85-100	1	1.25	
		2	0.4	40
		3	0.2 seal coat	
Ill.	Prime: MC-0 RT-1,2	1	0.25-0.50	35
	Cover: PA-3,4,5 RT-11,12	2	0.50-0.70 per 1" depth	
	Seal: PA-1,2 RT-11,12	3	0.30-0.50	40
Ind.	AP-3 RC-3 RS-2 RT-12	1	1/3 per 1" depth	
		2	1/4	45
		3	0.20-0.25	
Me.	Emulsified Asphalt	1	1	
		2	1	
		3	0.3 seal	35
		4	0.3 seal	
Md.[4]	AE-5	1	0.8 (3") 0.6 (2") 0.3 (1")	
		2	1.3 (3") 0.9 (2") 0.35 (1")	40
		3	0.4 seal (3") 0.4 seal (2") 0.4 seal (1")	
	85-100 RC-5 RT-12	1	1.5-2	
		2	0.50±	40
		3	0.1-0.2	
Mass.	85-100	1	—[5]	
	85-100	2	3/8 single seal	30
	RS-1 or CAE-1	3	1/2 and 3/8 double seal	
Mich.	85-100	1	0.75±	40
		2	0.25 seal	
Mo.	100-150	1	1.15-1.35 (3" course)	50
Mont.[4]	In plans or proposal	1	0.35	50
N. H.	85-100 100-120 MC or RC seal	1	—[5]	40 Base 25 Pavement
N. J.	85-100 100-120 RC-2,3 RT-7,8,9,10	1	1.75-2.25 (3" course)	
		2	0.5-0.75 (3" course)	
		3	0.33 (3" course)	
N. M.	120-150 MC-5	1	—[5]	40
N. Y.	Bottom course Asphalt-specified in proposal	1	0.5 per 1" depth	Type A 4.0 Deval
	Bottom course Tar - RT-12	1	0.4	Type B
		2	0.15 per 1" depth	5.7 Deval
	Top course "1" Asphalt-specified in proposal	1	1.75 per 3" depth	Type C
		2	0.5 seal	6.5 Deval
	Top course "1" Tar - RT-12 RT-10	1	1.5-1.6 per 2 1/2" depth	
		2	0.5-0.6	
		3	0.3-0.4 seal	
	Top course "2" Emulsion RS-1	1	0.9	
N. C.	MC-0 RC-0	1	Prime 0.35-0.40	
	AE-7	1	Prime 0.35-0.40	
	AP-0 RC-4	1	Mat 0.40-0.45	55
	AE-3	1	Mat 0.42-0.47	
	RC-1 RC-2	1	Seal 0.42-0.47	
	AE-3	1	Seal 0.45-0.50	
Ohio	Type A: RT-11,12	1	1.0-1.4 stone	
		2	1.0-0.6 stone	
		3	0.4 seal	24 Deval
	Type B: RS-1,2	1	1.2-1.5 slag	
		2	1.0-0.7 slag	
		3	0.4 seal	
Ore.	As called for by special provisions	1	0.20 1st course Type B-2	
		2	0.37 2nd course Type B-2	
		3	0.375 3rd course Type B-2	
		4	0.325-0.375 1st seal Type B-2	
		5	0.25 2nd seal Type B-2	
		1	0.20 1st course Type B-3	
		2	0.37 2nd course Type B-3	
		3	0.37 3rd course Type B-3	30
		4	0.375 4th course Type B-3	
		5	0.325-0.375 1st seal Type B-3	
		6	0.25 2nd seal Type B-3	
		1	1.00 2nd course Type B-11	
		2	0.375 3rd course Type B-11	
		3	0.325-0.375 1st seal Type B-11	
		4	0.25 2nd seal Type B-11	
Pa.	DL-2 or 3	1	Prime coat 0.25	
	C-1 NC-1 or CE-1	1	0.95	
	DH-2,3 HL-2,3 or H-3	1	0.85	
	C-1 NC-1 C-2 NC-2 or CE-1	2	0.25-0.35	
	DH-2,3 HL-2,3 H-2,3	2	0.30-0.45	
	C-2 NC-2 CE-1	3	0.25-0.35 seal	
	H-2 H-3	3	0.25-0.35 seal	
R. I.	OA-3 or NA-3	1	1.5-1.75 (3" course)	
		2	0.5-0.75 (3" course)	25
		3	0.4 seal	
Tenn.	85-100 100-120	1	0.6-0.9	
		2	0.3-0.5	40
		3	0.2-0.3	
Vt.	85-100 100-120	1	2 on #1 stone	
		2	0.5 on #2 stone (seal)	(5) Deval
Va.[4]	AP-3 RT-11	1	0.5 per 1" depth	43
		2	0.20-0.25 seal	
Wash.[4]	—[5]	1	1.20 3"mat on base	
		2	1.00 2 1/2" on base	
		3	0.80 2" on base	
		4	0.50 1 1/4" on base	
		1	0.30 3" mat on keystone	
		2	0.30 2 1/2" on keystone	
		3	0.25 2" on key-stone	
		4	0.25 1 1/4" on keystone	35
		1	0.12 3" mat on non-skid seal	
		2	0.12 2 1/2" on non-skid seal	
		3	0.12 2" on non-skid seal	
		4	0.12 1 1/4" on non-skid seal	
		1	0.30 3" mat on cement seal	
		2	0.30 2 1/2" on cement seal	
		3	0.30 2" on cement seal	
		4	0.30 1 1/4" on cement seal	
W. Va.	85-100 RC-4,5	1	1.0-1.8 Type A	
		2	0.4-0.7 Type A	40
		3	0.1-0.3 Type A seal	
	RT-10,12 RS-1,2	1	0.7-0.9 Type B	
		2	0.4-0.6 Type B	40
		3	0.2-0.3 Type B seal	
	Emulsion-Cationic Asphalt (Gravel only)	1	0.6-0.9 Type C	
		2	0.2-0.3 Type C seal	40

[1] State reports indicating no construction of bituminous macadam surface: Ala., Ariz., Ark., Calif., D. C., Fla., Iowa, Kan., Ky., Minn., Miss., Neb., Nev., N. D., S. C., S. D., Wis.
[2] No data available on bituminous penetration macadam base and surface courses: Colo., Ida., La., Texas, Utah, Wyoming.
[3] Maximum allowable.
[4] Have specification but do not make a practice of using this type of construction.
[5] As shown on plans or as ordered.

TABLE 2

STONE AND CHIPS SPECIFICATIONS FOR BITUMINOUS MACADAM SURFACE COURSE

State	Sieve Analysis (% passing)																					
	3 in.	2-1/2 in.	2-1/4 in.	2 in.	1-3/4 in.	1-1/2 in.	1-1/4 in.	1 in.	7/8 in.	3/4 in.	5/8 in.	1/2 in.	3/8 in.	1/4 in.	No. 4	No. 8	No.10	No. 16	No. 30	No. 50	No. 100	No. 200
(a) Stone																						
Conn.			100	95-100		35-70	0-25	0-10														
Del.			100	95-100		35-70		0-15				0-5										
Ga.		100		95-100		35-70		0-15				0-5										
Haw.		100		90-100		35-70		0-15														
Ill.		100		90-100		35-70		0-15				0-5										
Me.		100		95-100						0-15												
Md.		100		90-100		35-70		0-15				0-5										
Mass.			100	90-100		30-55	0-15	0-5														
Mich.		100		90-100		35-70		0-15				0-5										
N. H.			100	90-100		30-55	0-15	0-5														
N. J.			100				0-30			0-5				0-2								
N. Y.	100	90-100				0-20																
		100		90-100		35-70		0-15														
N. C.						100		93-100		25-45		0-10			0-2							0-0.3
Ohio	100	90-100		35-70		0-15																
Ore.		100					0															
Pa.						100		90-100				25-60			0-10	0-5						
R. I.			100	90-100		30-55	0-15	0-5														
Tenn.				100		90-100				0-15			0-3									
Vt		100		95-100				0-5														
Va.		100		95-100		45-80		0-15				0-5										
Wash.				100		50-70		0-10	0-5												0-0.5	
					100		50-70			0-10	0-3										0-0.5	
						100		50-70		0-10	0-3										0-0.5	
							100	90-100		0-10	0-3										0-0.5	
W. Va.		100		90-100		35-70		0-15				0-5										
				100		90-100		20-55		0-15			0-5									
						100		90-100		40-75		5-20	0-10		0-5							
(b) Keystone																						
Conn.											100	90-100	30-50		0-8	0-3						
Del.												100	75-100		10-30	0-10		0-5				
Ga.								100		90-100			0-15		0-5							
Haw.								100		90-100		20-55	0-15		0-5							
Ill.										100		90-100	40-75		5-25		0-5					
Me.								100		90-100		20-55	0-15									
Md.								100		90-100		20-55	0-15		0-5							
Mass.											100	85-100	15-45		0-15	0-5						
Mont.										100					40-70		25-55					2-10
											100				9-33		0-8					0-2
												100			9-50		0-8					0-2
													100		9-50		0-8					0-2
N. H.								100		90-100		10-40	0-20		0-5							
N. J.							100			95-100		30-50		0-10			0-2					
										100		60-85		15-35			0-5		0-2			
N. M.								100				0-20					0-4					
										100			0-25				0-4					
N. Y.						100		90-100				0-15										
								100				90-100		0-15								
Ohio										100		90-100	40-70		0-15	0-5						
Ore.						100				0												
							100			0												
R. I.								100		90-100		10-40	0-20		0-5							
										100	90-100	40-70	0-15		0-5							
Tenn.								100		97-100			0-5									
Vt.										100	95-100				0-15							
Va.								100		90-100			30-65		5-25	0-10		0-5				
Wash.									100	95-100		30-50		0-10			0-3				0-0.5	
W. Va.										100		85-100	35-70		0-10							
(c) Chips																						
Conn.												100	90-100		0-20	0-5					0-1.5	
Ga.												100	90-100		20-55	5-30		0-10		0-5		
														100	95-100			50-80		20-50	10-25	5-12
Haw.												100	85-100		10-30	0-10						
Ill.													100		20-45		0-5					
Me.										100		90-100			0-15							
Md.										100		90-100	40-75		5-25	0-5						
												100	85-100		10-30	0-10						
Mass.												100	85-100		20-50	0-15		0-5				
Mich.													100		80-95		0-20					
Mont.												100			0-20		0-2					
													100		0-20		0-2					
															100		0-2					
N. H.												100	30-60		0-15	0-5						
													100		0-15	0-5						
N. J.										100		95-100		20-50			0-5		0-2			
N. M.												100			0-20		0-4					
													100		0-15		0-4					
N. Y.								100				90-100		0-15								
												100		90-100		0-15						
N. C.												100	90-100		25-45		0-10					0-0.5
Ohio												100	80-100		10-35	0-5						
Pa.												100	75-100		10-30	0-10						
R. I.												100	30-60		0-15	0-5						
Tenn.								100		97-100			0-10		0-6							
Va.										100		90-100	40-80		5-25	0-10		0-5				
Wash.											100	85-100		0-15			0-3				0-1	
												100		90-100			30-60				0-10	
W. Va.												100	85-100		30-40	0-10						

APPENDIX B

HIGHWAY RESEARCH BOARD
DEPARTMENT OF MATERIALS AND CONSTRUCTION
COMMITTEE MC-7
BITUMINOUS AGGREGATE BASES

SURVEY OF BITUMINOUS BOUND BASE COURSE PRACTICES

As black bases have been in use for a number of years in many areas it is desirable to bring together, specifications, methods and other technology that exist. The resulting information should be of considerable value to different agencies when desired.

This report should cover information representative of current practices.

1. Name of agency reporting ______________________

2. Name of person answering this questionnaire ______________________

3. Estimated range of frost penetration under roadway ______________________

Table No. 1
Quantities

(Fill in tonnage of black bases applicable to your agency.)

	Estimated Tons per Year
A. General Information	
1. Type	
(1) Penetration Macadam or similar penetrated layers	______
(2) Mixed in place	______
(3) Coarse Aggregate Type plant mixed bases	
(a) Hot	______
(b) Cold	______
(4) Fine Aggregate Type mixed bases	
(a) Hot	______
(b) Cold	______
(5) Other types	
(a) Describe	______
	______
	______
2. Amount and type of material above placed under Portland cement pavement	______

TABLE 2 - MATERIALS AND QUALITY CONTROL

(Check or fill in appropriate spaces)

	(1) AGGREGATE LAYERS PENETRATED IN PLACE	(2) AGGREGATE LAYERS MIXED IN PLACE	(3) PLANT MIXES				(4) OTHER
			COARSE AGGREGATE TYPE		FINE AGGREGATE TYPE		
			(a) HOT	(b) COLD	(c) HOT	(d) COLD	
1. Bituminous Material							
(a) Type							
(b) Grade							
2. Coarse Aggregate							
(a) Type:							
Gravel							
Stone							
Slag							
Blends of above							
Other							
(b) Processing:							
Crushed							
Screened							
Scalped only							
Proportioned							
Other							
(c) Quality Acceptance:							
Los Angeles							
Soundness							
Other							
3. Fine Aggregate							
(a) Type:							
Natural							
Stone sand screenings							
Blends of above							
Other							
(b) Processing:							
Washed							
Unwashed							
Other							
(c) Quality:							
Uniformity							
Fineness modulus							
Sand equivalent							
Other							

TABLE 3 - MIX DESIGN, METHODS AND CRITERIA

(Indicate Range of Value in appropriate space)

	(1) AGGREGATE LAYERS PENETRATED IN PLACE	(2) AGGREGATE LAYERS MIXED IN PLACE	(3) PLANT MIXES				(4) OTHER
			COARSE AGGREGATE TYPE		FINE AGGREGATE TYPE		
			(a) HOT	(b) COLD	(c) HOT	(d) COLD	
1. Hveem Stability Test							
Stability							
Cohesiometer							
Air Voids							
% Voids filled with A.C.							
2. Marshall Stability Test							
Stability							
Flow							
Air Voids							
% Voids filled with A.C.							
3. Triaxial Tests							
Values required							
Air Voids							
% Voids filled with A.C.							
4. Gyratory Test							
Values required							
Air Voids							
% Voids filled with A.C.							
5. Hubbard Field Test							
Values required							
Air Voids							
% Voids filled with A.C.							
6. Unconfined Compression							
Load, lbs/sq in.							
Air Voids							
% Voids filled with A.C.							
7. Gradations							
Check if gradation is							
only requirement							
8. Others (Specify Criteria)							

Note: Designate maximum size aggregate used for each test.

TABLE 4 - SPECIFICATIONS AND CONSTRUCTION PRACTICES

Indicate Range of Values or check in appropriate spaces)

	(1) AGGREGATE LAYERS PENETRATED IN PLACE	(2) AGGREGATE LAYERS MIXED IN PLACE	(3)				(4) OTHER
			COARSE AGGREGATE TYPE		FINE AGGREGATE TYPE		
			(a) HOT	(b) COLD	(c) HOT	(d) COLD	
. Gradation							
Sieve Size % Passing							
. Typical Residual Asphalt Content							
(% of Mixture)							
. Field Control							
(a) Density Required							
(b) Thickness Required							
(c) Smoothness Required							
(d) Roller Weight Required							
(e) Rolling Pattern Required							
. Construction Methods							
(a) Maximum Thickness per Lift							
(b) Placing Equipment (specify)							
(c) Roller Types (pneumatic, tandem,							
3-wheel, etc.)							
(d) Temperatures of Mixtures							
(1) At plant							
(2) In paver							
(e) Environmental Limitations							
(1) Ambient temperature requirement							
(2) Wind velocity limitations							

TABLE 4 - SPECIFICATIONS AND CONSTRUCTION PRACTICES (Continued)

Page 2 of 2

(Indicate Range of Values or check in appropriate spaces)

	(1) AGGREGATE LAYERS PENETRATED IN PLACE	(2) AGGREGATE LAYERS MIXED IN PLACE	(3) PLANT MIXES				(4) OTHER
			COARSE AGGREGATE TYPE		FINE AGGREGATE TYPE		
			(a) HOT	(b) COLD	(c) HOT	(d) COLD	
(3) Substrata temperature							
(4) Frozen subgrade limitations							
(Yes or No) give limitations							
(5) Paving season limitations							
(6) Disposition of mix rained out							
or delayed							
5. Thickness							
(a) Overall Thickness of Black Bases							
(b) Is Bituminous Mix Placed Directly							
on Subgrade?							
(c) Describe Experience							
(d) Equivalency Ratio (granular vs							
black base)							
6. Average Overall Bid Price/Ton in Place							
(1968)							
7. Comments on Performance:							
Were Black Bases Built Prior to 1968?							
Was Performance Satisfactory?							
Were Changes Made Recently?							
(a) Why?							
(b) Describe							
General Comments:							

Date Submitted ______________________

Submitted by ______________________

Title ______________________

Organization ______________________

Please return questionnaire before October 1, 1969

To: Mr. Charles Parker, Chairman
Summary and Evaluation Subcommittee
Committee MC-A7, Highway Research Board
Engineering Laboratory Service
58 Main Street
Westbrook, Maine 04092

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HIGHWAY RESEARCH BOARD
NATIONAL ACADEMY OF SCIENCES—NATIONAL RESEARCH COUNCIL
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