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16. Abstract

The objective of this study is to analyze available data on early flushing sections of Superpave mixes in Nebraska and to have a better understanding of the possible causes. Records indicated that construction of the flushed sections were normal and that all QA/QC tests were in the acceptable ranges. TSR testing on those sections was acceptable. Anti-strip additives were used in part of the distressed sections. In cases, projects under the same contract had flushed and non-flushed sections. A review of mix design parameters of all flushed sections was conducted to verify compliance with Superpave specifications. Comparisons to same parameters of non-distressed sections of identical mixes were also conducted. Field samples from flushed and non-flushed sections were obtained and analyzed for both mix design verifications and binder characterization. Additional testing on recovered binders was conducted to assess their contribution to this problem. Results indicated that mix design parameters and recovered binder properties did not adhere to the Superpave specifications. The observed flushing was caused by one or more factors related to the mix and binder specifications that were considered in the construction of these sections.

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Introduction

Mix bleeding, or binder flushing, is migration of the bitumen to the surface of the flexible pavement, with or without fines. Krishnan and Rao (1, 2) indicated that migration can happen by means of two mechanisms: first, by the diffusion of asphalt into the air voids when it is subjected to temperature exceeding its softening point and second by the movement of asphalt due to pressure gradient developed in asphalt. The development of this pressure gradient is due to the reduction of air voids under traffic loads. Both mechanisms can occur simultaneously and the contribution of each depends very much on the temperature-stiffness relationship of the binder, the air voids distribution in the mix and the traffic loads to which the pavement is subjected to. Literature (3, 4) lists mix segregation and binder contamination during the construction process as possible causes of binder flushing.

Objectives

The objective of this study is to analyze available data on early flushing sections of Superpave mixes in Nebraska and to have a better understanding of the possible causes.

Superpave Flushing Cases in Nebraska

Binder flushing was observed in pavement sections with Superpave level-2 mixes (SP-2) in Nebraska. The sections were constructed between 1999 and 2000 and flushing was observed from 2000 to 2002. At the time of construction, quality assurance (QA) data by the Nebraska Department of Roads (NDOR) and quality control (QC) data by the contractors showed compliance with the then current specifications of SP-2 mixes. Figure 1 shows a map of the State of Nebraska with the locations of flushed sections. The distribution shown indicates that flushing was not region specific. SP-2 is a county road mix with a majority of natural aggregate components. Table 1 shows current design criteria for SP-2 mixes. Values shown in the table may be slightly different from the specifications at the time the flushed sections were constructed. NDOR provided records of thirty five projects with SP-2 mixes. Eleven sections had PG58-28 binders. Five of the PG58-28 sections were flushed. Twenty four sections had PG 64-22 binders with only one case exhibiting low severity flushing in limited areas. Table 2 shows a list of the sections considered in this study. The flushed sections were reported to have an Average Daily Truck Traffic (ADTT) from 190 to 230, both ways.

The most rapid onset of flushing occurred within few weeks after construction. That was in the summer of 2000 on Highway-43. Because of the high severity of flushing, the surface was milled late 2000 with no further rehabilitation actions. Flushing was observed again in the same section in late summer 2002, but with a much lower severity. During the 2000 flushing case, field cores were obtained and analyzed by the Western Research Institute (WRI) for chemical and physical properties on the binder and by NDOR for mix parameters (5). Table 3 and Figure 2 from the report by WRI provide sample results of testing on the original and extracted binders. The study by WRI did not find any conclusive evidence as to the cause of the flushing problem on Highway-43 but the analysis showed very unusual chemical properties of the extracted asphalt that were significantly different from the original asphalt and most likely contributed to the problem. Results by WRI showed lower boiling point materials in the extracted cores that did not exist in the original binder. Extracted binders were substantially softer than the original binder. There were indications of low compatibility asphalt that may suffer separation and behave as an oily material. The original mix design called for 5% asphalt by weight while flushed cores showed higher asphalt content with an average value of 6.99% by weight. Non-flushed cores showed an average value of 4.92% asphalt content. The report by WRI also indicated that similar problems were experienced in other states at about the same time.

More flushing cases were observed between 2000 and 2002. The condition ranged from medium to severe. Flushing usually started with a few spots of asphalt on the pavement surface. The number of asphalt spots continued to increase during the hot summer days. The spots gathered to form a distressed area and the size of the affected areas continued to increase during the summer time. All sections had scattered flushed areas, up to 200 feet long with one, or both, wheel paths flushed. None of the affected sections were fully flushed. No significant rutting was reported in any of the flushed sections and surface conditions were very good with no indication of any defects. Cores taken from the flushed areas showed no signs of moisture-related distresses.

Study Plan

A study plan was developed that included comparisons with selected non-flushed sections, analysis of QA/QC data for both flushed and non-flushed sections and randomly drilling cores in and adjacent to the flushed sections and in the non-flushed sections. A few hypotheses on the interaction of the aggregate sources with the asphalt sources were considered at the beginning of the research program. To examine these hypotheses, specific non-flushed sections were selected by NDOR for comparisons based on similarity of asphalt sources, principle contractors of both flushed and non-flushed sections, year of construction and aggregate sources. The comparisons helped examine specific factors in the design and construction of SP-2 mixes. The selected sections are listed in Table 2. As shown in the table, all severely flushed sections were associated with PG58-28 binders that were supplied by different suppliers. Only a single case with PG64-22 in Highway-23 had low severity flushing. Visits to each of the flushed sections revealed that the flushing of Highway-23 was insignificant as compared to the other flushed sections. It was also clear there is no evidence that natural gravel contributes to the flushing problem. The non-flushed sections contain higher percentages of natural gravel than the flushed sections. The same applied to the RAP content. More non-flushed sections, than flushed sections, had RAP. Only one flushed section was found with a 15% RAP content. Possibilities of moisture-related causes were also minimized. QA/QC data indicated that tensile strength ratio (TSR) on flushed sections were passing specification requirements. Anti-strip additives were used in some of the flushed sections. None of the drilled cores in flushed sections showed any moisture-related damage due to the adhesion between asphalt and aggregate. To examine the possibility of moisture damage due to failure in the cohesion of the asphalt paste, attention was paid to the binder extraction process (ASTM D 1856-95a). None of the binder extraction cases of the flushed sections reported the existence of water in the solvent-asphalt solutions.

More than eighty cores were drilled from both flushed and non-flushed sections. Selected cores were tested as needed. Testing included binder physical properties and mix design parameters. Overlays were one lift of 2.0 in. for all sections except for Highway-56 that has two lifts, each with 2.0 in. thickness. Cores were obtained with 6.0 in. depth. The most recent top 2.0 in. overlays were split into two 1.0 in. layers. Mix parameters were determined for each 1.0 in. layer. Average values were used in the analysis of mix parameters as no significant differences were found between the two 1.0 in. thick halves. Binder physical properties did not include extracted material from the top 1.0 in. half because it was subjected to further oxidation, contamination and other causes of aging that prevented an accurate estimation of true binder properties. Binder content was based on the average of the two 1.0 in. halves. For Highway-56 the bottom 2.0 in. layer was treated separately from the upper layer and was not further separated into two parts. It was recognized that each of the original 2.0 in. layers belonged to a different construction lot as they were not constructed at the same time. As will be presented in a next section, testing on cores, QA/QC data and calculations of pavement temperature indicated that flushing occurred in the upper 2.0 in. layer.

Results and Discussion

Considering the report by WRI, inspecting the flushed locations, reviewing QA/QC data on mix components, the study was focused on few main aspects: the binder nature and physical properties, the mix design parameters including the use of local materials and the suitability of SP-2 mix for traffic conditions, mix variability and in-situ mix quality. Summary and examples of the testing results are listed in this report. A complete list of all testing results including binder and mix parameters are listed in the attached appendices. Appendix A presents plots illustrating the variability of the binder and mix parameters within and between construction lots. Appendix B lists testing results on the extracted binders from field samples. Appendix C presents an analysis of the pavement surface temperatures as a potential factor, combined with the asphalt PG grade, affecting binder flushing.

Analysis of Binder Properties

Table 4 and Table 5 show the properties of extracted binders from field cores as compared to QA/QC data on original binders. The listed values were verified through additional extraction and testing. Flushed sections were three to four years in service. Original materials were PG58-28 with testing at 58 °C for RTFOT and at 19 °C for PAV parameters. One would expect extracted binders to be stiffer than RTFOT but may be softer than PAV materials. Results showed extracted binders vary in stiffness but are all softer than RTFOT materials and significantly softer than PAV materials. In two cases, extracted binders were softer than the original, un-aged, material. Similar results were obtained by WRI in the 2000 Highway-43 flushing problem. The chemical analysis by WRI on the Highway-43 samples indicated compatibility concerns with the extracted binders. Thermal analysis showed a lower molecular weight material than the original asphalt in the extracted binder. It is known that asphalt compatibility progresses with aging and may lead to phase separation producing a solid, asphaltene-like material, dispersed in a relatively fluid medium. The separated solid material may not be extracted with solvents. Hence, the soft extracted binder might not include the separated solid part. The analysis on binder separation minimized the possibility of contamination as a cause of softer extracted binders. It is to be noted that NDOR does not apply any QA testing on binder separation. QA testing on binder separation is not common in HMA construction. PG binders are purchased with a certification from the suppliers.

G* Sin δ @ 19 °C and G*/Sin δ @ 58 °C values as obtained from QA/QC records were based on average testing results at the time of construction. It was not possible to refer cores data to exact construction lots due to data availability. All QA/QC data showed compliance with the then current specifications on binder grade. Recovered binders from drilled cores showed significant variability in properties that were not present in the QA/QC data. That variability could be attributed to the construction process including possible segregation of mix components. It is believed that additional QA measures are needed to ensure more consistent SP-2 mix quality.

The selection of asphalt grade for SP-2 mixes in Nebraska was questioned. All sections with significant flushing had PG58-28 binders. Only one section with PG64-22 showed insignificant flushing, Highway-23. Reports by district engineers indicated that flushing was associated with high summer temperature times. An analysis of pavement temperature for the past four years was conducted for all flushed locations. The objective was not to examine the current PG grade system in Nebraska but rather to study if exceptional pavement temperature was a factor in the flushing problem. Flushing occurs when pavement temperature is high enough to cause softening of the binder so that it can flow under the effect of traffic loads. The analysis of pavement temperature can help determine the depth of pavement to consider as a source of flushed binder. SHRP procedures for Superpave specifications (6) were applied to the temperature analysis. Data on maximum daily air temperature and section longitude and latitude was collected from local sources. All basic assumptions that were documented in the original SHRP reference were applied in this study. One of the critical assumptions in the SHRP procedures was the maximum temperature difference between the surface and a 2.0 in. (50.0 mm) depth during hot summer days. That was assumed in the SHRP report between 10 °F and 20 °F. Table 6 presents the average maximum seven days pavement temperature, 20.0 mm below surface, for Highway-56 over the past four years. The table presents two cases; the first case is for a difference of 15 °F, $d_{(0-50)}$ = 8.3 °C. The second case is for a difference of 10 °F, $d_{(0-50)}$ = 5.6 °C. In both cases; pavement temperature was higher than what was expected for a PG58 grade mix with the second case being more critical. Figure 3 presents a frequency, in days, of maximum daily temperature based on the assumption of

$d_{(0\text{-}50)}$ = 5.6 °C for Highway-56. The figure shows that pavement temperature, 20.0 mm below surface, was higher than 58 °C for about sixty days in each of the past three years. The presented data shows that a PG64 binder would be a better choice for the Highway-56 location. Same conclusions were reached for the locations of the other flushed sections. It is to be noted that NDOR stopped using PG58 grade binders in Superpave mixes since the 2001 construction season. While the pavement maximum temperature was higher than what was assumed for all flushed sections, it was concluded that temperature at the 4.0 in. depth was not sufficient to soften the existing binder enough to flow. Testing on extracted materials confirmed this finding. The above discussion on binder quality suggests that an adhesion problem that may have been caused by binder separation has contributed to the flushing problem. The damage due to asphalt-aggregate adhesion is accelerated in mixes with softer binders.

Effects of Mix Parameters

Having air voids in an asphalt mix is unavoidable but it is necessary to engineer specific related parameters. About 4% voids in the total compacted mix at optimum asphalt content is acceptable. This void content must be achieved in the field during construction through compacting effort and not by adding asphalt cement to fill up the voids. Besides, a balanced amount of dust, material passing the #200 sieve, is required to regulate the function of the binder in the mix. Low dust to binder ratio (D/B) results in excessive binder content and can lead to softening of the mix and/or flushing of the binder. But high D/B may lead to fatigue cracking. The parameters related to the voids in asphalt mix are; asphalt content, D/B ratio, total voids and voids filled with asphalt (VFA). Table 7 presents average values of these parameters as obtained from the records of the original mix design, QA/QC testing, and testing on flushed and non-flushed cores. Flushed sections had high asphalt contents (AC). In some cases the AC was higher than what was originally determined in the mix design. In the case of Highway-56, mix design was based on 5.0% AC but flushed cores were showing an average of 5.9%. In the case of Highway-43 the mix design was based on 5.0% AC but flushed cores were showing an average of 5.7% AC, with some values as high as 7.0%. In other cases the original mix designs were based on high AC. In the case of Highway-15 the original design called for 5.7% AC and Highway-26 specified 5.7% AC. On the other hand, all mix designs of non-flushed sections were based on an AC of 4.7% to 5.2%. Cores and QA/QC records of non-flushed sections showed 4.4% to 5.1% AC. Table 7 shows that D/B ratios of flushed sections were significantly lower than those of non-flushed sections. All flushed sections were originally designed with D/B of 0.5 to 0.6. Values from QA/QC records and from flushed cores showed a slightly higher value of (0.8) for both Highway-56 and Highway-15 and a lower values of 0.3 for Highway-43 and 0.4 for Highway-26. Non-flushed sections had D/B ratios as high as 1.2 with no signs of fatigue cracking after three to four years of service. It is clear that the high AC coupled with the low D/B ratio were factors in this flushing problem. The earliest two sections to flush after construction, Highway-43 in few weeks and Highway-26 in few months, had the lowest D/B ratios.

Theoretically, binder flushes if VFA reaches unity (1, 2). The VFA value depends on the volume of air voids and the effective binder content in the mix. It can be seen that most of the cores had higher VFA values as compared to the mix design or the QA/QC values but none of the flushed sections had a VFA close to unity. Depending on how the air voids are structured and connected, the voids can be effective in containing the binder when flowing and flushing may be avoided. The numbers from Table 7 show that air voids values for both flushed and non-flushed sections remain close to 4.0% so that a conclusion on the effect of the volume of air voids on this flushing problem can not be reached. This argument supports the literature on the effectiveness of the structure, or distribution, of air voids in preventing binder flushing.

No meaning conclusions on the causes of the flushing problem can be reached without considering the aggregate effects. But aggregate contribution to the flushing cases is tied to the binder content. Testing shows the binder contents of few flushed sections are on the low side but even more so the passing sieve #200 materials. VFA values were all on the low side for the traffic levels using the researched sections. As shown in Appendix A, contents of aggregate sizes passing sieve #30 were relatively low, may be because of the restricted-zone rule applied to the SP-2 mix designs. This significantly decreases the surface area of fine aggregate and allows extra binder contents to exist in the matrix and hence flushing occurs when other conditions including high pavement temperature and softer, or lighter, binder quality exist. Again, the use of natural gravel was not a main cause of the flushing distress as researched in this study.

QA/QC Considerations

The figures presented in Appendix A suggest that a primary cause of the flushing distress is the variation of properties of the plant produced mix. Temperature within a pavement section that flushed should not be different from the temperature within a pavement section that did not flush. Temperature, alone, is not a cause of flushing unless something else is contributing the problem. The nature of this flushing problem as non-continuous distressed areas can be attributed to the variability in mix parameters and binder properties. As shown for extracted binder properties, mix parameters varied in both QA/QC records and in core testing. Figure 4 presents an example of a lot-by-lot binder content and D/B ratio for Highway-56. As can be seen in the figure, significant variability existed within a lot and between lots. Recovered binder samples were almost 2.0% higher than the design binder content and in cases softer than the original binders. As discussed earlier, softer field binders can be attributed to a separation problem. However, QA testing on binder separation is not common in HMA construction. PG binders are purchased with a certification from the suppliers. Records do not confirm if a tack coat was used on the flushed sections? If so, that might account for some of the bleeding.

Effect of Traffic

Figure 5 illustrates an example of the effect of traffic on the severity of flushing. The figure shows one coring location of the intersection of Highway-15 with Highway-32. Note the extension of Highway-32 as a farmer-market unpaved road to the right. Highway-15 is a two-lane road. In this location, cores 1 and 2 were drilled in the right-turn lane to the low-volume-road with low or no heavy traffic. Cores 3 and 4 were drilled in the through north-bound heavy traffic lane. Cores 5, 6 and 12 were drilled in the left-turn lane to Highway-32 with heavy traffic. Cores 7, 8 and 11 were drilled in the south-bound lane with heavy traffic. Cores 9 and 10 were drilled in the right-turn from Highway-32 into Highway-15 with a lower heavy traffic volume than that of a through traffic lane. AC and D/B parameters were not significantly different between flushed and non-flushed cores in this location. Binder properties were even softer for low flushing severity than for high severity flushing. This case shows that flushing severity can be related to traffic volumes.

Summary of Findings and Recommendations

This study presents cases of Superpave mix bleeding caused by the combined effects of both asphalt properties and mix design parameters. Binder flushing, or mix bleeding, depends very much on the temperature-stiffness relationship of the asphalt used, air voids distribution in the pavement and traffic loads to which the pavement is subjected to. Extracted binder samples from flushed sections varied in their physical and chemical properties but were all significantly softer than what would be expected. It is believed that problems in the asphalt source, mostly related to compatibility, caused the separation of the light fractions of the binder in the top pavement layers. High pavement temperatures and heavy traffic accelerated the flushing process. It was also noted that flushed sections had a softer asphalt grade than non-flushed sections. This indicates that a stiffer binder would have been less likely to flush. All flushed sections had excessive binder content and insufficient dust. The above discussion on binder quality suggests that an adhesion problem that may have been caused by binder separation has contributed to the flushing problem.

Additional measures in the QA process are needed to ensure more consistency in the construction process. That need was demonstrated by the variability in the properties of extracted binders and in the mix parameters from field cores and QA/QC records.

Flushing occurred in spite of the fact that an acceptable percentage of air voids was present. Voids in the mix were mostly filled with high asphalt content in the asphalt-dust paste. An appropriate D/B ratio is critical to balance the mix performance between mix softening or binder flushing on one hand and fatigue cracking on the other hand. It is critical to further study the role of air voids in the mechanism of mix bleeding, or binder flushing. Two aspects are to be considered; first is the nature, structure and/or distribution, of air voids in an asphalt mix as related to binder flushing. Second is examining that nature during the mix design process.

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TABLE 1 Superpave Mix Level-2 in Nebraska

Gyratory Level	**(N_{des} 76)** **(N_{max} 117)**
FAA	**Min. 43**
VMA	**Min. 13**
VFA	**65-78**
Use Natural Aggregate	

TABLE 2 Considered SP-2 Sections

Pavement Sections	**Binder Grade**	**Condition**	**Year of Construction**	**Year Flushing Observed**	**Natural Gravel**	**Crushed Gravel**	**Crushed Rock**	**RAP**
HWY-56	PG58-28	Flushed	1999	2002	47.0%	15.0%	22.0%	None
HWY-43	PG58-28	Flushed	2000	2000/ 2002	42.0%	20.0%	19.0%	None
HWY-23	PG64-22	Slightly Flushed	2002	2002	34.0%	48.0%	18.0%	None
HWY-15	PG58-28	Flushed	2000	2002	41.0%	25.0%	20.0%	15.0%
HWY-26	PG58-28	Flushed	2000	2000/ 2002	43.0%	50.0%	10.0%	None
HWY-66	PG58-28	Non-Flushed	2000	NA	13.0%	55.0%	15.0%	15.0%
HWY-92	PG58-22	Non-Flushed	1999	NA	46.0%	10.0%	19.0%	15.0%
HWY-75	PG64-22	Non-Flushed	2000	NA	50.0%	13.0%	12.0%	25.0%
HWY-74	PG64-22	Non-Flushed	2000	NA	30.0%	50.0%	20.0%	None

TABLE 3 Summary of Thermal Analysis of the Highway-43 Samples (5)

Sample	Glass Transition Temperature, T_g, ^0C	Crystalline Content, mass %
Original PG 58-28	-25.3	2.4
Extracted Good Core Top	-26.3	2.6
Extracted Bad Core Top	-29.4	2.0
Extracted Bad Core Bottom	-27.2	2.3

TABLE 4 Testing on Extracted Binders @ 58 °C

			G*/SINδ, KPa	G*, KPa	δ, Deg
HWY-56 (Flushed Section)	Core No.	18	**1.651**	**1.645**	**85.14**
		19	**1.647**	**1.642**	**85.29**
		21	**1.601**	**1.596**	**85.48**
		22	**0.9387**	**0.936**	**86.17**
	Un-aged, Original		**1.15**		
	RTFOT, Original		**2.65**		
HWY-15 (Flushed Section)	Core No.	1 (No-Flushing)	**2.859**	**2.842**	**83.81**
		3	**1.97**	**1.965**	**85.95**
		5	**1.535**	**1.532**	**86.05**
		7	**1.714**	**1.71**	**85.88**
		9	**0.7933**	**0.7923**	**87.07**
	Un-aged, Original		**1.28**	**1.278**	**87.13**
	RTFOT, Original		**2.886**	**2.872**	**84.27**
HWY-66 (Non-Flushed Section)	Core No.	2	**6.322**	**6.238**	**80.62**
		4	**6.184**	**6.101**	**80.59**
	Un-aged, Original		**1.18**		
	RTFOT, Original		**2.98**		

TABLE 5 Testing on Extracted Binders @ 19 °C

			G* SINδ , KPa	G*, KPa	δ , Deg
HWY-56 (Flushed Section)	Core No.	18	**1039**	**1187**	**61.13**
		19	**1041**	**1195**	**60.64**
		21	**1056**	**1208**	**60.90**
		22	**628.4**	**706.1**	**62.86**
	PAV, Original		**3730**		
HWY-15 (Flushed Section)	Core No.	1 (No-Flushing)	**1925**	**2331**	**55.68**
		3	**2774**	**3342**	**56.11**
		5	**1435**	**1648**	**60.57**
		7	**1386**	**1603**	**59.86**
		9	**585.4**	**642.9**	**65.58**
	PAV, Original		**4096**	**5931**	**43.68**
HWY-66 (Non-Flushed Section)	Core No.	2	**2698**	**3517**	**50.1**
		4	**2773**	**3633**	**49.74**
	PAV, Original		**4056**		

TABLE 6 Average Maximum Seven Days Pavement Temperature, Highway-56

Year	**d $_{(0-50)}$ = 8.3 °C**	**d $_{(0-50)}$ = 5.6 °C**
1999	57.24	63.43
2000	58.08	64.48
2001	58.45	65.01
2002	59.44	65.01
Mean	**58.30**	**64.48**
Std Dev.	**0.91**	**0.75**

TABLE 7 Mix Design and Parameters for Flushed and Non-Flushed Sections

		% Binder	Dust/ Binder	Air Voids	VMA	VFA	FAA	%Pass #200
HWY -56	Mix Design	5.0	0.5	3.8	14.5	73.8	40.0	2.5
	QA/QC	5.2	0.9	4.1	15.2	73.3	41.0	4.8
	Flushed Cores	5.9	0.8	3.7	15.3	75.8	40.3	4.7
	Non- Flushed Cores	5.3	0.8	2.9	14.1	79.2	40.6	4.2
HWY -15	Mix Design	5.7	0.6	5.5	17.9	69.2	41.1	3.7
	QA/QC	5.7	0.7	4.1	16.5	75.2	41.0	4.2
	Flushed Cores	5.5	0.8	5.8	16.6	65.4	41.0	4.6
	Non- Flushed Cores	5.6	0.8	3.0	15.21	80.1	40.4	4.8
HWY -43	Mix Design	5.0	0.6	6.0	16.8	64.4	43.5	3.4
	QA/QC	5.1	0.8	3.6	14.4	75.3	42.1	4.0
	Flushed Cores	5.7	0.3	3.9	14.3	72.2	41.5	4.4
HWY -26	Mix Design	5.7	0.5	4.2	15.5	72.7	43.0	2.8
	QA/QC	5.3	0.4	3.7	14.0	75.8	43.2	4.5
HWY -23	Mix Design	5.5	0.5	5.4	15.8	65.8	43.6	2.5
	QA/QC	5.5	0.5	3.6	15.1	70.1	42.6	2.9
HWY -66	Mix Design	4.7	1.1	4.2	14.0	69.9	41.2	5.4
	QA/QC	4.7	1.0	4.0	14.0	71.7	42.6	4.6
	Non- Flush Cores	4.4	1.2	3.7	14.0	73.7	41.7	5.4
HWY -92	Mix Design	5.0	0.8	6.1	15.0	58.0	42.4	3.9
	QA/QC	4.6	0.9	4.9	14.2	65.6	40.3	3.9
HWY -74	Mix Design	5.2	0.7	4.5	16.2	72.2	40.5	3.7
	QA/QC	4.9	0.7	3.8	14.9	75.5	NA	3.7
HWY -75	Mix Design	5.2	1.2	3.7	14.6	74.3	41.2	5.3
	QA/QC	5.1	1.0	3.9	14.0	72.3	41.0	5.0

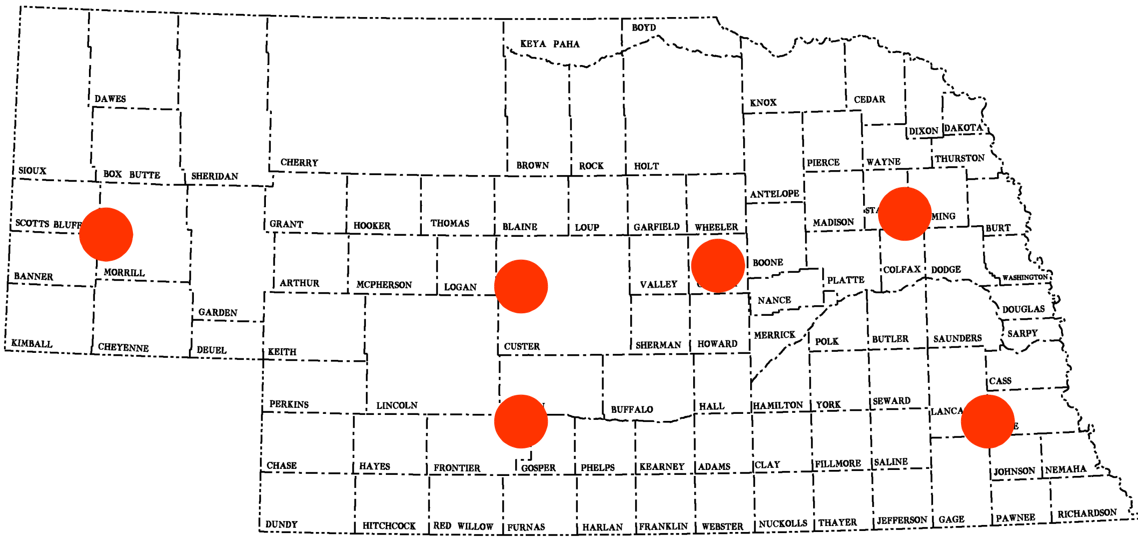

FIGURE 1 Map of Nebraska with Locations of Flushed Sections.

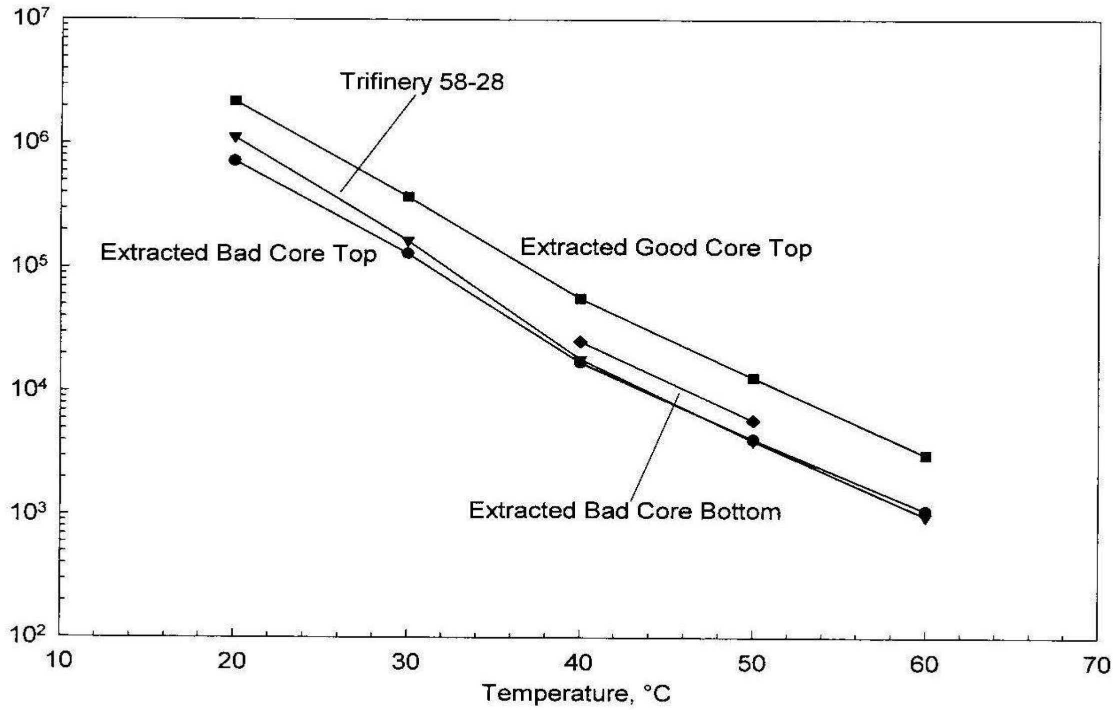

FIGURE 2 Comparisons of Extracted Cores and Original Asphalt by WRI (5).

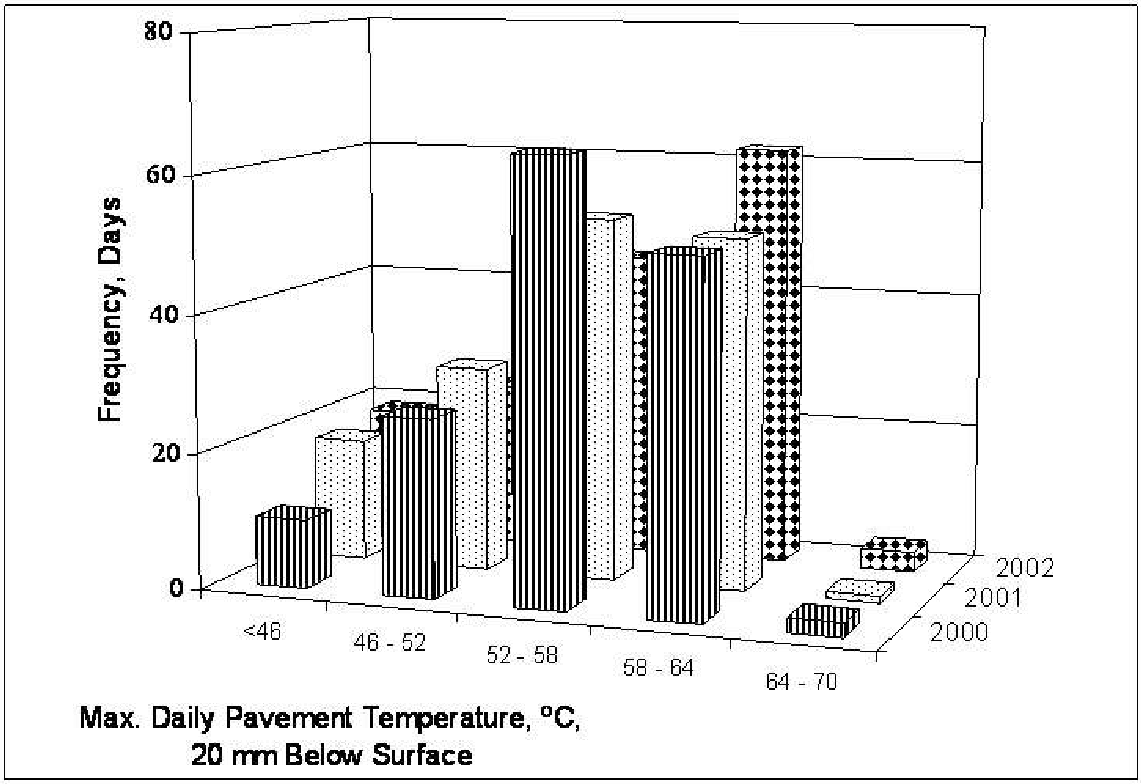

FIGURE 3 Frequency of Maximum Daily Pavement Temperature, Highway-56.

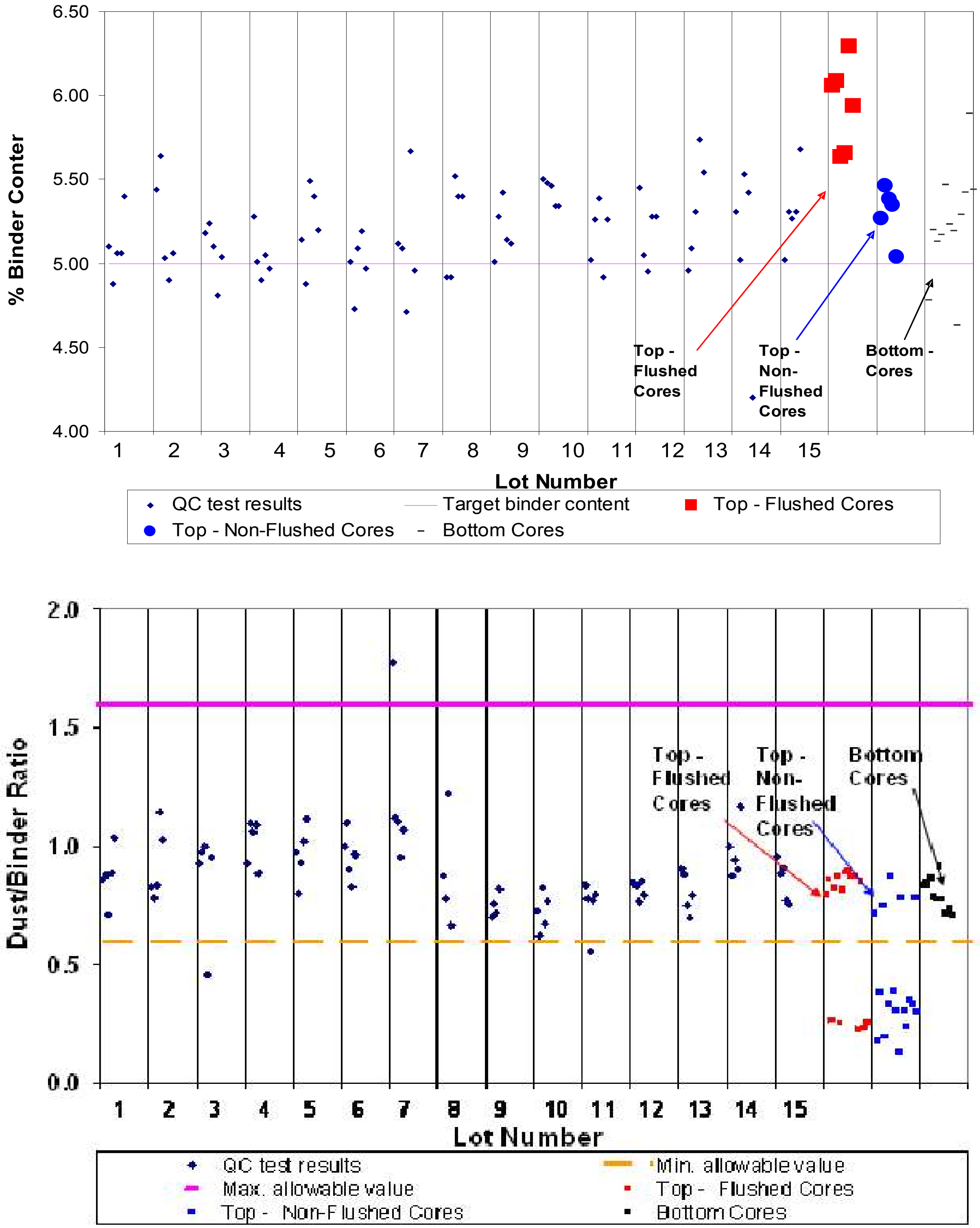

FIGURE 4 Comparisons of QA/QC Data with Field Cores for Highway-56.

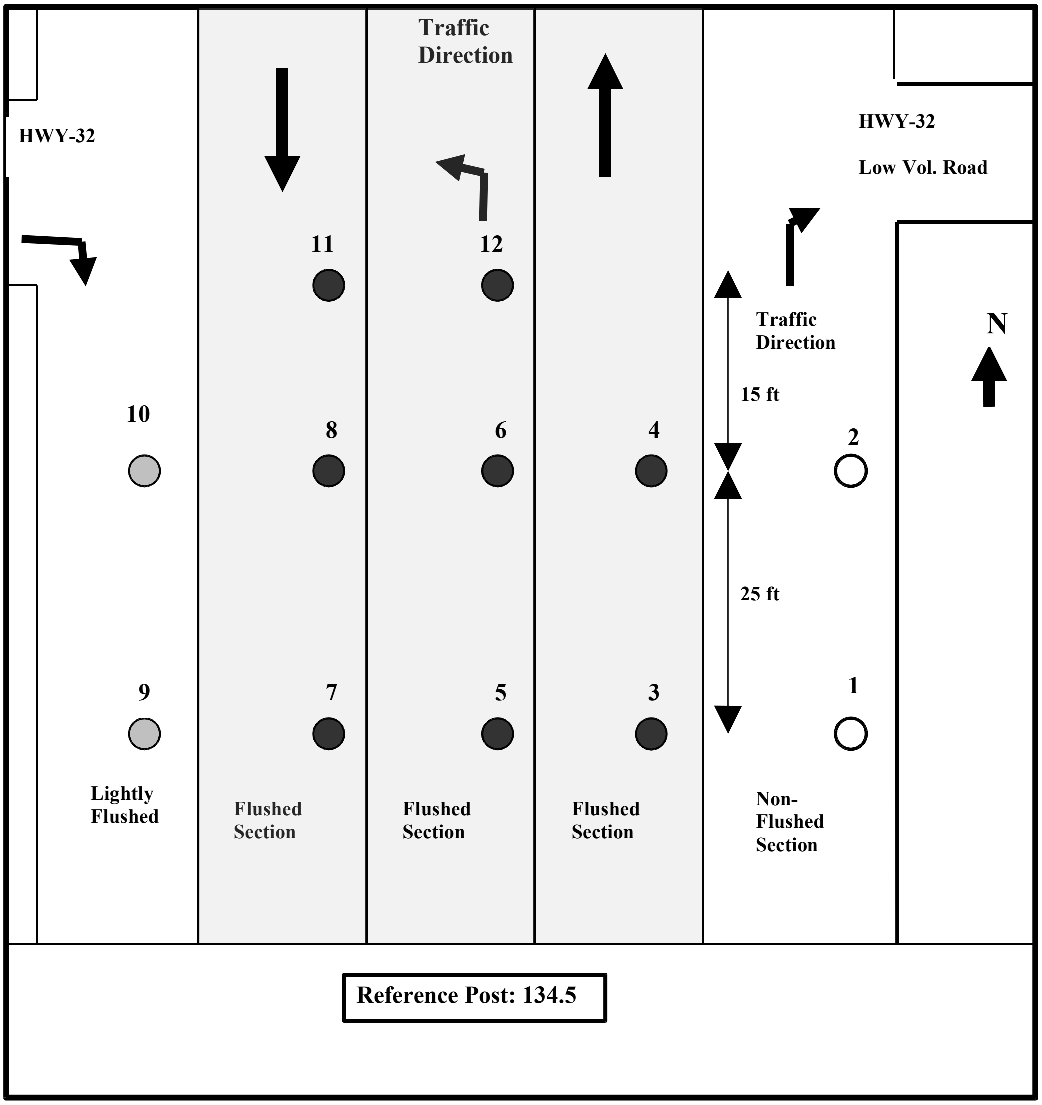

FIGURE 5 Effects of Traffic Loads on Flushing Severity.