Superpave Implementation Across Canada 1994-2001:

Part I Results from the 2001 Canadian Superpave Implementation Tracking Study (C-SITS)

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EXECUTIVE SUMMARY

As a major product of SHRP, the Superpave system has received much attention from the Canadian Strategic Highway Research Program (C-SHRP) through its technology transfer (T^2) mandate including the purchase of test equipment, construction and monitoring of test sections, distribution of technical briefs and conduction of cross country information sessions.

This latest implementation survey, known as the Canadian Superpave Implementation Tracking Study (C-SITS), was conducted in the fall of 2001 and represents the second major Canadian survey of Superpave implementation by the provincial transportation agencies. Since the 1998 C-SHRP survey, all of the senior provincial governments have acquired experience with the Superpave test equipment. Therefore, C-SITS was developed to quantify and monitor the actual amount of Superpave asphalt that has been placed in Canada, as well as collect detailed data from specific Superpave projects for future reference. The distribution of the 2001 survey was also expanded to include municipal agencies and private consultants/contractors.

Of the over 200 surveys distributed via email, 41 responses were received in 2001 representing, all 10 provinces, the federal government and 30 municipalities. No private consultants or contractors responded to the survey. Of these agencies, 10 provincial, 8 municipal and 1 federal indicated that they have some experience with Superpave mix design (not simply the performance graded binders), whereas the other 23 agencies indicated no previous experience with Superpave (or have experience with PG binders alone).

The total amount of Full Superpave asphalt mix reportedly laid between 1994 and 2001 in Canada is just over 4.13 million tonnes, while the total amount of asphalt produced with PG binder and the Marshall method is slightly more than 28.3 million tonnes. The amount of Full Superpave constructed per year has steadily increased from approximately 90,000 tonnes placed in 1994 to 913,377 tonnes in 2000.

As of mid 2001, only the Provinces of Quebec and Ontario have completely implemented the PG binder specification (MTQ in 1996 and MTO in 1998, respectively). The Atlantic Provinces (New Brunswick, Nova Scotia, Prince Edward Island and Newfoundland) will likely implement the specification by the end of 2001 or shortly thereafter. None of the western provinces (British Columbia, Alberta, Saskatchewan and Manitoba) have implemented the PG binder specification, however, as the availability of high quality asphalt cement has made the adoption of the specification redundant according to those agencies.

In terms of the Superpave mix design system, only the City of Vancouver has completely switched to asphalt mix design using the gyratory compactor, although they continue to specify asphalt cements according to the Canadian General Standards Board (CGSB) penetration grading system to obtain lower material cost. The Province of Quebec has greatly increased the amount of gyratory compacted mix designs in the past years and will likely switch completely in the coming years.

In terms of construction issues, most of the responding agencies have experienced one or more of the construction concerns, particularly increased roller pickup. However, most of the concerns have been remedied to an acceptable degree with continued experience placing Superpave mixes.

The main result of this survey was that, ***as of the end of 2001, there are no (responding) agencies in Canada that have adopted both the PG binder specification and the Superpave mix design system.*** The provincial and municipal agencies are currently waiting to observe the performance of existing test sections or projects before increasing their implementation efforts. Various unresolved technical issues such as the lack of a mix performance test, complete adherence to the restricted zone, loose guidelines for the inclusion of recycled (or reclaimed) asphalt products (RAP) and fine aggregate angularity test have also delayed the adoption of Superpave in Canada. Some agencies are also concerned that Superpave will not allow the use of various mixes that have years of demonstrated performance in the field. Recent and ongoing research through the National Cooperative Highway Research Program (NCHRP) is expected to resolve many of these concerns.

Overall, it appears that with continued monitoring and experience, it is likely that Superpave will see progressive adoption by Canadian road agencies. C-SHRP will continue to act as technology transfer liaison with the United States Federal Highway Administration (FHWA) and Transportation Research Board (TRB) to ensure that Canadian agencies have the latest information concerning Superpave technology.

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INTRODUCTION

Background

In response to a perceived increase in the amount of severe rutting and cracking in hot mix asphalt pavements during the 1980's, the Superpave (SUperior PERforming Asphalt PAVEments) was developed by the United States Strategic Highway Research Program (SHRP) "to give highway engineers and contractors the tools they need to design asphalt pavements that will perform better under extremes of temperature and heavy traffic loads" (FHWA 1996). The Superpave system was designed around three interrelated elements:

i) A performance-graded (PG) asphalt binder specification,
ii) A volumetric mix design and analysis system based on the gyratory compactor,
iii) Mix analysis tests and a performance prediction system.

When originally released in 1992/93, the third element was not sufficiently mature for inclusion in the system. As will be discussed in following sections, significant effort is currently being expended to bring the mix analysis tests and performance prediction system online.

Detailed review of the Superpave system is beyond the scope of this report. Interested parties are encouraged to refer to the SP manual series published by the Asphalt Institute (1997 and 2001), as well as the C-SHRP technical brief series (1998, 1999 and 2000) for additional information.

C-SHRP and Superpave

As a major product of SHRP, the Superpave system has received much attention from the Canadian Strategic Highway Research Program (C-SHRP) through its technology transfer (T^2) mandate. With continued experience and research, Superpave has observed numerous changes since its inception. During this time, C-SHRP has continued its role as technology conduit from the US across Canada through a number of technology transfer efforts including equipment purchase, test section monitoring, technical briefs and cross country information sessions. C-SHRP and the Transportation Association of Canada (TAC) have also contributed to the Superpave system, most notably through extensive research by Robertson (TAC 1997) and Anderson, Christison and Johnston (TAC 1999) in the area of low temperature pavement cracking and performance graded (PG) binder selection. C-SHRP also conducts periodic surveys to monitor the implementation of Superpave throughout Canada.

Scope

The latest implementation survey, known as the Canadian Superpave Implementation Tracking Study (C-SITS), was conducted in the fall of 2001 and represents the second major Canadian survey of Superpave implementation by the provincial transportation agencies. The primary objective of this report is to present the Part I results of the 2001 C-SITS survey.

The report begins with a review of previous surveys including the 1998 C-SHRP Superpave Implementation Survey and the 1999 C-SHRP survey of Superpave education within Canadian university and college civil engineering programs. The C-SITS survey methodology is then

introduced, followed by the 2001 results obtained from provincial and municipal agencies. Recent Superpave related research results and ongoing projects through the National Cooperative Highway Research Program (NCHRP) are then reported and the report concludes with a section containing a summary and conclusions.

PAST IMPLEMENTATION SURVEYS

1998 Superpave Implementation Survey

A questionnaire was distributed in April 1998 to all provincial highway agencies to obtain information concerning the implementation of Superpave (Aurilio and Wells 1998). The survey consisted of 26 questions dealing with general issues such as availability of testing equipment, construction of trial projects and future plans for additional projects and research, to more specific questions regarding implementation schedule, specifications development, asphalt binder supply and construction concerns. Selected survey results are shown in Table 1.

At that time, approximately 50% of the provincial agencies possessed the Superpave asphalt binder testing equipment, while 60% were equipped with gyratory compactors to complete Superpave volumetric mix designs. Respondents identified that a majority of the asphalt cement suppliers had the ability to conduct PG binder testing. Several consultants across Canada also possessed the capability to conduct the asphalt binder testing and/or volumetric mix designs.

A majority of the provinces indicated that trial projects had been constructed in previous years. These projects ranged from purely experimental in nature (i.e. SPS-9A projects) to projects that incorporated aspects of the Superpave system with more conventional contracts. The SPS-9A sites that were constructed under the Long Term Pavement Performance (LTPP) program constituted most of the projects constructed to date. Three provinces had constructed multiple Superpave trials. A number of western provinces indicated that existing asphalt cement specifications were not a concern and thus concentrated the research on Superpave mixes only.

With regard to construction, the responses and comments echoed many of the concerns noted by agencies in the United States such as rubber tire pick-up associated with the use of modified binders, segregation due to coarser mixes, compaction problems and slight to moderate wheelpath flushing/rutting. Two provinces reported concerns with aggregate quality and supply, indicating that some sources did not meet the Superpave aggregate criteria.

In terms of implementation, most of the provinces were anticipating some problems, however, these did not seem to be insurmountable. Among the biggest concerns was the potential for higher cost. This includes equipment and testing cost (e.g. QC/QA), but more significantly higher costs for materials. Several provinces indicated that the current specifications for asphalt cement in particular were adequate. Others were concerned with the use of PG binder with reclaimed asphalt pavement (RAP), supply and storage of multiple grades and aggregate compatibility with antistripping agents. Proper evaluation and the absence of conclusive validation were also given as strong reasons for deferring or delaying Superpave implementation.

All of the provinces agreed and indicated that further education was definitely needed. Updates on the ongoing trials and studies were noted as being very important in the further development and implementation of Superpave. One province indicated that additional education might assist in obtaining buy-in and support from upper management. One-day seminars were viewed as the main method of transfer of information and courses similar to FHWA were noted as being very beneficial. It should be noted that in response to this recommendation, C-SHRP sponsored a highly successful series of one-day briefing sessions concerning Superpave in October of 1998.

Table 1: Summary of 1998 Superpave Implementation Survey

Province	Testing Capability			Projects			Problems/Concerns
	PGAB	Gyratory	Equipment Availability	PGAB	Gyratory	TOTAL	
British Columbia	*	✞	P, C		✞	4	Segregation Mix unforgiving in cool temperatures
Alberta			C, A	✞	✞	6	No significant problems during construction; Minor to moderate wheel-path flushing and rutting w/PG 46-34
Saskatchewan	✞	✞	T/A	✞	✞	1	Compaction more difficult; Mixes extremely porous; aggregate sources rejected; recycling ratio limited; No strength test
Manitoba	✞	✞	T/A	✞		1	Contractor had problem with sticky binder (modified)
Ontario	✞	✞	S, C, M, T	✞	✞	1	Pick-up problems w/rubber tired rollers
Quebec	✞	✞	S, A, T	✞	✞	1	Problems with mix formulation
Nova Scotia			T/A		✞	1	Superpave mixes coarser; Mix did not meet stripping criteria; difficulty w/moving lab equipment; increase time and manpower to complete mix design.
New Brunswick	✞	✞	S	✞	✞	1	Mix instability during compaction, Volumetric mix design was reworked several times to stay out of the restricted zone
Newfoundland				✞		2	Slight problem with adhesion to rollers w/ PG 52-34
Yukon							Very limited infrastructure; lack of equipment

P: Hot Mix Producer, C: Consultant, A: Academia, S: Supplier, T: Transportation Agency, T/A Jointly Operated. * Rotational Viscometer (Brookfield) only.

1999 University/College Curriculum Survey

In an effort to establish the level of Superpave instruction at Canadian academic institutions, a survey of civil engineering programs was completed in 1999. The survey was very basic in nature, simply inquiring as to whether the institution included Superpave in their curriculum or not and whether Superpave education was provided by way of a specific course or as an inclusion to existing courses. Of the 30 surveys distributed, 13 were returned (43% response) and the results are summarized in Table 2.

Table 2: Selected Results of 1999 University Survey

Institution	Do you currently offer a specific Superpave course?	Do any courses partially include Superpave?
Carleton University (Ontario)	No	Yes
McGill University (Ontario)	No	Yes
Memorial University of Newfoundland	No	No
Royal Military College (Ontario)	No	Yes
Ryerson Polytechnic University (Ontario)	Yes	N/A
University of Alberta	No	Yes
University of Calgary (Alberta)	Yes	N/A
University of Manitoba	Yes	N/A
Université de Moncton (New Brunswick)	No	Yes
University of New Brunswick	No	Yes
University of Saskatchewan	No	Yes
Université de Sherbrooke (Quebec)	Yes	N/A
University of Waterloo (Ontario)	Yes	Yes

As shown, responses were received from institutions across the country including Alberta, Saskatchewan, Manitoba, Ontario, Québec, New Brunswick and Newfoundland. Twelve of the 13 respondent institutions offer Superpave instruction in some form, whether offered as a separate course or incorporated into other pavement and/or materials courses. At this stage, most were happy with their level (number of courses, etc.) of Superpave instruction, however some do plan on adding additional courses in the near future. These results were very encouraging as they indicated that future generations of civil engineers will possess the latest transportation information when they enter the workforce. For completing the survey, each responding institution received a Superpave information package including the FHWA CD-ROM entitled "Hot Mix Asphalt for the Undergraduate Including the Superpave Mix Design System, which can be downloaded from the FHWA website at http://www.fhwa.dot.gov/asphtech.htm.

2001 CANADIAN SUPERPAVE IMPLEMENTATION TRACKING STUDY (C-SITS)

Survey Methodology

Since the 1998 C-SHRP survey, all of the senior provincial governments have either acquired Superpave test equipment themselves, or have access to such equipment through private consultants. Therefore, the C-SITS survey was created to obtain new information. Specifically, the primary goals of C-SITS are to quantify and monitor the amount of Superpave asphalt that has been placed in Canada, as well as collect detailed data from specific Superpave projects. C-SITS was developed to be a dynamic and continuing project so that the rate of implementation may be monitored with time.

In addition to the new format, the distribution of the survey was also increased to include municipal agencies and private consultants/contractors. The 2001 C-SITS survey form is included as Appendix A and is organized in two parts as outlined below.

C-SITS Survey Part I

As shown in Appendix A, Part I of the survey was a single page developed to quantify the yearly tonnage of two categories of asphalt mix. The first category, referred to as **"Full Superpave,"** includes asphalt mix incorporating PG asphalt cement and designed with gyratory compaction according to the guidelines set out by the Asphalt Institute in Manual SP-02, and/or the American Association of State Highway and Transportation Officials (AASHTO) Standard MP2. The second category, referred to as **"PG Binder Only"** includes asphalt mix incorporating PG asphalt cement, but that was designed using the Marshall mix design system.

In addition to yearly tonnages, Part I also inquired as to whether or not the agency had adopted the Superpave mix design system into its operating specifications and reasons if they had not. The agencies were also asked whether or not they had experienced some of the construction concerns observed in the US such as mix tenderness, compaction difficulty, segregation, roller pickup and stripping and whether these concerns had been mitigated through additional experience. Final questions concerned the added cost of Superpave asphalt mix (if any) and whether or not the agency felt that the cost was justified.

C-SITS Survey Part II

Part II of the survey form is also included in Appendix A. As shown, Part II was much more detailed in nature and was to be filled out on a project level basis. Part II data was requested in the hope that Superpave projects could be monitored with time to observe their performance.

Survey Distribution

The Transportation Association of Canada (TAC) membership database was used to develop a list of contacts from provincial and municipal governments, as well as a number of private consultants. The survey was delivered via email to over 200 recipients. Completed surveys were to be returned to C-SHRP via email, surface mail or fax.

Part I Results

General Results

A total of 41 responses were received, representing a 20% response rate. Table 3 displays a list of the responding agencies grouped by province. As shown, all 10 of the senior provincial government agencies provided responses, as well as a number of municipal agencies, Yukon Territory and Public Works and Government Services (federal government). No private consultants responded to the survey.

Of the 41 responses, 19 agencies (10 provincial, 8 municipal and 1 federal) indicated that they have (or continue to) experiment with Superpave mix design (not simply PG binders) for test sites or construction projects, whereas the other 23 agencies indicated no previous experience with Superpave (or have experience with PG binders alone). As many of the larger municipalities responded to the survey (with or without Superpave experience), it is suspected that the majority of the 160 agencies who did not respond do not have experience with Superpave.

Table 3: 2001 Superpave Implementation Survey Responding Agencies

Province	Agency Name	Population (Statistics Canada)	Experimented with Superpave Mix Design?
British Columbia	Ministry of Transportation - Central Region	4095900	Yes
	Ministry of Transportation - Northern Region		No
	City of Surrey	304500	Yes
	Town of Smithers	5600	No
	District of Powell River	13100	No
	Municipality of Saanich	101400	No
	City of Kamloops	84900	No
	City of Abbotsford	136500	No
	City of Vancouver	1912100	Yes
Alberta	Alberta Transportation	3064200	Yes
	City of Airdrie	16000	No
	Regional Municipality of Wood Buffalo	36100	No
	City of Red Deer	60100	No
	City of Edmonton	885100	Yes
	City of Calgary	845500	Yes
Saskatchewan	Highways and Transportation	1015800	Yes
	City of North Battleford	18000	No
	City of Moose Jaw	34800	No
	City of Regina	199500	Yes
Manitoba	Transportation and Government Services	1150000	Yes
	City of Winnipeg	679200	No

Table 3 Continued: 2001 Superpave Implementation Survey Responding Agencies

Province	Agency Name	Population (Statistics Canada)	Experimented with Superpave Mix Design?
Ontario	Ministry of Transportation	11874400	Yes
	City of Waterloo	78000	No
	County of Brant	3500	No
	County of Wellington	1700	No
	Northumberland County	75000	No
	City of Ottawa	1038000	Yes
	Regional Municipality of Durham	502700	Yes
	United Counties of Prescott and Russell	70500	No
	Town of Tillsonburg	13200	No
	Regional Municipality of Halton	339000	No
	City of Toronto*	4403100	Yes
Quebec	Ministère des transports	7410500	Yes
New Brunswick	Department of Transportation	757100	Yes
	City of Moncton	113500	No
Nova Scotia	Transportation and Public Works	942700	Yes
Prince Edward Island	Transportation and Public Works	138500	Yes
Newfoundland	Works, Services and Transportation	533800	Yes
	City of Corner Brook	28000	No
Yukon Territory	City of Whitehorse	19150	No
Federal Government	Public Works and Government Services Canada	n/a	Yes

*only one region/district from the City of Toronto responded to the survey.

Total Tonnages

The total amount of Full Superpave asphalt reportedly laid between 1994 and 2001 in Canada is just over 4.13 million tonnes, while the total amount of asphalt produced with PG binder but using the Marshall method is slightly more than 28.3 million tonnes. In terms of Full Superpave, 85% of the total tonnage has been placed by provincial agencies, while the remaining 15% has been placed by municipal agencies. For PG Binder Only, the provincial governments have placed 93% of the total, while municipal governments have placed the remaining 7%.

The total amount of Full Superpave and PG Binder Only across Canada is presented by year in Figure 1. As shown, the amount of Full Superpave has steadily increased from approximately 90,000 tonnes in 1994 to 913,377 tonnes in 2000. The decrease in Full Superpave observed in 2001 is somewhat misleading, as the Ministère des transports du Quebec did not provide 2001 tonnages in their completed survey.

The huge increase in the amount of PG Binder Only asphalt observed in 1998 is due primarily to the adoption of the PG binder specification by the Ontario Ministry of Transportation in that year.

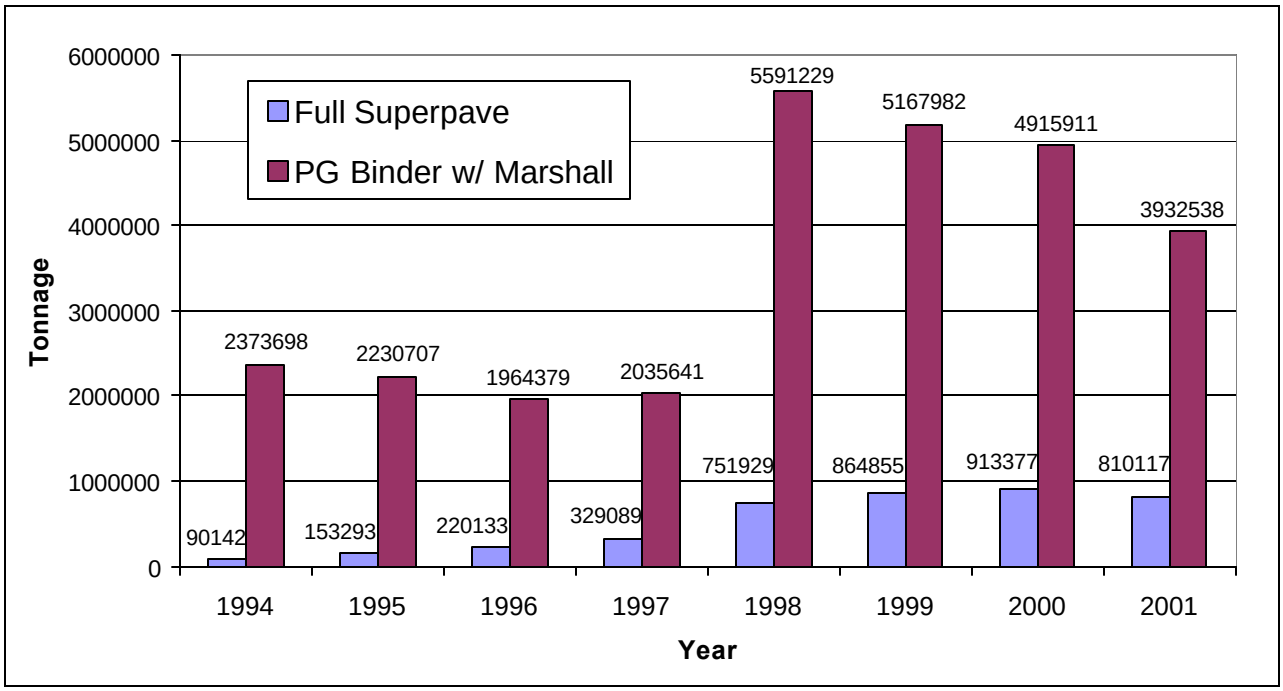

Figure 1: Asphalt Tonnage vs. Year from 1994 to 2001 (All Agencies Combined)

Interestingly, a general decrease in the amount of PG Binder Only asphalt was observed from 1997 to 2000. It is clear from Figure 1 that this trend is not due to increased use of Full Superpave. Instead, it is more likely due to an overall decrease in the amount of asphalt laid by the responding agencies from 1998 to 2000. Again, the large decrease in PG Binder Only asphalt observed from 2000 to 2001 is exagerated, as the Ministère des transports du Quebec did not provide 2001 tonnages.

Tonnages by Province

The totals reported in the previous section are further separated by province (includes both provincial and municipal agencies) in Table 4. As shown, Quebec possesses the most Full Superpave with over 1.93 million tonnes, followed closely by Alberta with over 1.64 million tonnes. British Columbia has the third largest amount at 368090 tonnes, while the remaining provinces have significantly less than the top three provinces. In terms of PG binder only, Ontario possesses the most asphalt with over 14 million tonnes, followed by Quebec with over 12.4 million tonnes.

Table 4: Tonnages by Province (All Agencies)

Province	Total Tonnages	
	Full Superpave	**PG Binder Only**
British Columbia	368090	103100
Alberta	1647526	260790
Saskatchewan	28187	11489
Manitoba	3250	16950
Ontario	20500	14012772
Quebec	1934432	12420529
New Brunswick	104300	835000
Nova Scotia	26650	457080
PEI	0	178000
Newfoundland	0	10400

Tonnages – Provincial vs. Municipal Agencies

The breakdown of tonnages by agency and province is displayed in Table 5. In the Provinces of British Columbia and Saskatchewan, the vast majority of Full Superpave asphalt has been constructed by municipal agencies as opposed to the province, whereas the reverse is true for Alberta, Manitoba, Ontario, Quebec, New Brunswick and Nova Scotia. In terms of PG Binder Only, all of the provincial agencies have constructed the majority (usually all) of the PG Binder Only asphalt with the exception of Saskatchewan. The results for Quebec, Nova Scotia and PEI may be misleading, as no municipal agencies from those provinces responded to the survey.

Table 5: Provincial and Municipal Tonnages by Province

Province	Provincial Agency (tonnes)		Municipal Agencies (tonnes)		Provincial % of Total (%)	
	Full SP	**PG Binder**	**Full SP**	**PG Binder**	**Full SP**	**PG Binder**
British Columbia	1800	103100	366290	0	0.5	100
Alberta	1436926	260790	210600	0	87.2	100
Saskatchewan	5000	5000	23187	6489	17.7	43.5
Manitoba	3250	16950	0	0	100	100
Ontario	18000	12000000	2500	2012772	87.8	85.6
Quebec	1934432	12420529	0	0	100	100
New Brunswick	104300	835000	0	0	100	100
Nova Scotia	26650	457080	0	0	100	100
PEI	0	178000	0	0	n/a	100
Newfoundland	0	10400	0	0	n/a	100

Municipal Full Superpave

At this time, only 6 of the 30 responding municipalities have actually placed Full Superpave asphalt mix as shown in Table 6. When the data in Table 6 were plotted against municipal population, an interesting trend was observed as shown in Figure 2. It is apparent that a (somewhat weak) relationship between population and tonnage of Superpave placed exists and that municipalities with greater population are not only more likely to try Superpave, but have placed more tonnage as well. These results are intuitively reasonable.

Table 6: Tonnage of Full Superpave Mix Placed by Municipal Agencies

Municipality	Tonnes of Superpave Mix Placed (1994-2001)
City of Surrey, BC	96290
City of Vancouver, BC*	270000
City of Edmonton, AB	45100
City of Calgary, AB	165500
City of Regina, SK	23187
Regional Municipality of Durham, ON	2500

* the City of Vancouver does not use the Superpave PG binder specification, but has switched to gyratory compaction. Refer to following section.

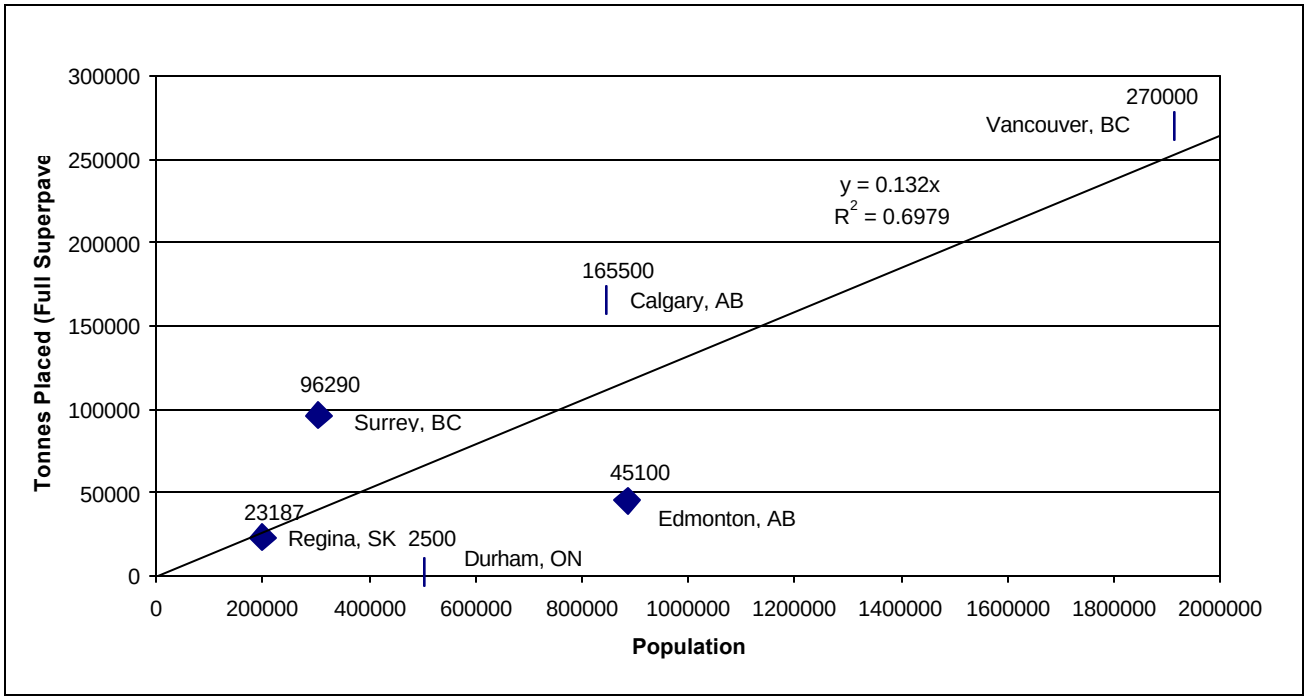

Figure 2: Tonnage of Full Superpave Placed versus Municipal Population

Agencies That Have Adopted Superpave

The main result of this survey was that, ***as of the end of 2001, there are no (responding) agencies in Canada that have adopted <u>both</u> the PG binder specification and the Superpave mix design system.***

The Provinces of Quebec and Ontario have completely implemented the PG binder specification (MTQ in 1996 and MTO in 1998, respectively) and most of the Atlantic Provinces will likely implement the specification by the end of 2001. None of the western provinces have implemented the PG binder specification, however, as the availability of high quality asphalt cement has made the adoption of the specification redundant according to those agencies.

In terms of the Superpave mix design system, only the City of Vancouver has completely switched to asphalt mix design using the gyratory compactor, although they continue to specify asphalt cements according to the Canadian General Standards Board (CGSB) penetration grading system to obtain lower material cost. The City has tested their typical binders (CGSB Group 80-100 Grade A) using Superpave protocols and observed that these binders are equivalent to PG 64-22 or PG 64-28 depending upon the source.

The Province of Quebec has increased the amount of gyratory compacted mix designs in the past years and will likely switch completely in the coming years. However, the mix design system used by the MTQ is a combination of Superpave and the LCPC method developed in France by the Laboratiore Central des Ponts et Chausses.

Barriers to Implementation

Some of the comments as to why the agencies have not yet implemented Superpave are grouped below in order of the number of similar responses received:

i) Performance of test sections or initial projects still underway (7 responses)

ii) Premium cost for asphalt cement or aggregates (5 responses)

iii) Limited experience (4 responses)

iv) Waiting for provincial or regional adoption (3 responses)

v) Technical issues with current Superpave specification and test procedures including lack of performance test (2 responses)

vi) Not in current municipal master plan (2 responses)

vii) Used only in high traffic areas (1 response)

viii) Permeability concerns (1 response)

ix) Scarcity of aggregates to meet Superpave specifications (1 response)

x) Rutting not an issue. Full Superpave not needed as use of PG binders has reduced thermal cracking (1 response)

Based on the responses above, it appears that the provincial and municipal agencies are currently waiting to observe the performance of existing test sections or projects before increasing their implementation efforts. Various unresolved technical issues such as the lack of a mix performance test, complete adherence to the restricted zone, loose guidelines for the inclusion of recycled (or reclaimed) asphalt products (RAP) and fine aggregate angularity test have also delayed the adoption of Superpave. Some agencies are also concerned that Superpave will not allow the use of various mixes that have years of demonstrated performance in the field. As will be presented later, many of these concerns are currently under investigation through NCHRP and will likely be resolved in the coming years.

Construction Concerns

The agencies were also asked whether they had experienced various construction problems while paving with Superpave mixes. The results are shown in Table 7. As shown, most of the responding agencies have experienced one or more of the construction concerns, particularly increased roller pickup. However, the increased roller pickup had more to do with the use of polymer modified asphalt binders than the actual Superpave specification. Furthermore, it appears that most of the concerns have been remedied to an acceptable degree with continued experience placing Superpave mixes.

Table 7: Construction Concerns Observed with Superpave

Construction Concern	Experienced During Construction?		Specific Comments
	Yes	No	
Mix Tenderness During Compaction	8	11	Difficult to hand work mixes (1 response)
Compaction Difficulty (Stiff Mix)	6	13	
Increased Segregation	5	14	
Increased Roller Pickup	10	9	Increased roller pickup with rubber tired roller when using polymer modified asphalt cements (4 responses)
Increased Stripping	2	17	
Concerns Remedied with Continued Experience?	10	3	Not enough experience at this time to say that concerns have been remedied (2 responses)

Cost Increase?

As shown in Appendix A, the agencies were simply asked "What is the average percentage increase in cost of Superpave asphalt vs. Marshall asphalt that your agency has experienced?" Based on the responses received, it was clear that the question was not specific enough. For example, some agencies gave a simple percentage increase, while others provided the percentage increase in cost of testing, materials, etc. The results have been grouped into ranges based on the responses and are shown in Table 8.

Table 8: Increased Cost for Superpave versus Marshall

Percentage Increase in Cost	Number of Responses	Specific Comments
No Increase	6	
0 to 10%	6	• $1 per tonne extra with non-PG binder (1 response) • PG binder $2.00/tonne more than Penetration graded (1 response) • 10% for PG binder (1 response)
11 to 15%	3	
Not Enough Information	1	
Other	2	• 25-30% based on PG binder with Marshall design • 75% extra for PG binder testing (since agency purchased lab equipment)

One third of the responding agencies have not observed any increase in cost to use Superpave mix, while a further one third have experienced between 0% and 10% increase in cost. Three agencies reported that a cost increase between 11% and 15% was observed while one agency could not confidently report whether or not a cost increase was observed due to the small amount of mix placed.

Worth the Cost?

Finally, the agencies were asked whether or not they felt the added performance of Superpave justified the extra cost (if any). Six agencies responded with an answer of "Yes" while 1 agency did not believe that the performance justified the extra cost. Four agencies could not confidently respond either way due to lack of information to date. Obviously, the question was not applicable to agencies that did not experience increased cost for Superpave mix.

In future surveys, this section of the survey may be expanded to inquire whether or not any additional performance has been observed with Superpave, in addition to whether or not the extra cost is justified.

Part 2 Responses

Many of the agencies did not submit Part II of the survey despite having Superpave projects within their jurisdiction. The primary reasons for this were the level of effort required to complete the survey, as well as lack of requested information for projects completed in the past. A number of Part II surveys have been received, however. These surveys will be reviewed in the near future and reported elsewhere.

RECENT AND EXPECTED SUPERPAVE RESEARCH ACTIVITIES

Recent Research Results

Through the NCHRP, a number of research projects have been completed (and are currently underway) to improve the Superpave mix design system and PG binder specification. Three major projects that have been recently completed are described below. As new research is completed, various groups such as TRB Expert Task Groups and the AASHTO Subcommittee on Materials review the results prior to adoption. The following project descriptions may be found through the NCHRP section of the TRB website at www.trb.org.

NCHRP 9-10 Superpave Protocols for Modified Asphalt Binders

There is concern that the Superpave binder and mixture tests may not be suitable for use with various modified asphalt binder systems. SHRP research established test methods and specification limits for neat asphalt cement binders, as well as tests and prediction models for mixtures made using neat asphalt cements. These specification limits, prediction models, and test methods, including volumetric criteria, were established from limited correlation of field performance with laboratory-measured properties of neat binders and mixtures made using the neat binders.

The objectives of this research were (1) to recommend modifications to the Superpave asphalt binder tests for modified asphalt binders and (2) to identify problems with the Superpave mixture performance tests in relation to mixtures made using modified asphalt binders.

The following items have been transmitted to the TRB Binder Expert Task Group for review and possible future action by the AASHTO Highway Subcommittee on Materials: (1) a recommended practice, in AASHTO standard format, for advanced characterization of the performance properties of modified and unmodified asphalt binders; (2) methods for estimating practical laboratory mix and compaction temperatures of modified binders, their storage stability, and their particulate additive content; and (3) recommendations for changes to the present AASHTO specifications MP1 and MP1A and test methods TP1, TP3, and TP5.

The final report was published in August 2001 as NCHRP Report 459.

NCHRP 9-12 Incorporation of Reclaimed Asphalt Pavement in the Superpave System

Although there is widespread use of reclaimed asphalt pavement (RAP), research performed under SHRP did not address the issues associated with use of RAP in hot-mix asphalt mixtures. Consequently, the Superpave system did not provide guidelines to characterize asphalt binders extracted from RAP and recycled hot-mix asphalts. Because Superpave is gradually becoming the sole means for design and analysis of asphalt mixtures, research is needed to develop guidelines and procedures that will incorporate RAP in the Superpave system.

The objectives of this research were to (1) develop guidelines for incorporating RAP in the Superpave system and (2) prepare a manual that can be used by laboratory and field technicians.

Results are available in NCHRP Report 452 and Research Results Digest 253.

NCHRP 9-14 Investigation of the Restricted Zone in the Superpave Aggregate Gradation Specification

In the experience of many paving engineers, compliance with the restricted zone criteria may not be desirable or necessary in every instance to produce paving mix designs that give good performance. For example, when aggregate particles in the size range of the restricted zone are highly angular, it is likely that high-quality, rut resistant, non-tender paving mixes can be produced. Furthermore, some highway agencies and suppliers can provide examples of aggregate gradations that pass through the restricted zone, but produce paving mixes that have performed well. The key issue for this research is to determine under what conditions, if any, compliance with the restricted zone requirement is necessary when the paving mix meets all other Superpave fine aggregate angularity (FAA) and volumetric mix criteria for the project.

The objectives of this research were to determine through evaluation of the performance properties of hot mix asphalt (HMA) if the restricted zone requirement is redundant with fine aggregate angularity (FAA) and volumetric mix criteria and, if appropriate, to identify the traffic levels at which it is redundant.

The results indicate that the restricted zone requirement is redundant if the mix design strictly meets all other Superpave volumetric design requirements. The final report has not yet been published.

Ongoing and Expected NCHRP Projects

In addition to the completed projects above, a number of ongoing research projects are listed in Table 9 with their anticipated completion dates.

Table 9: Active NCHRP Projects Concerning Superpave

NCHRP Project	Title	Anticipated Completion Date
9-16	Relationship Between Superpave Gyratory Compaction Properties and Permanent Deformation of Pavements in Service (Active)	April 15, 2002
9-19	Superpave Support and Performance Models Management	August 9, 2003
9-21	Advisory Structure for Superpave Implementation and Related Research	Ongoing
9-25	Requirements for Voids in Mineral Aggregate for Superpave Mixtures	October 2, 2003
9-29	Simple Performance Tester for Superpave Mix Design	April 1, 2003
9-31	Air Void Requirements for Superpave Mix Design	October 14, 2003

SUMMARY AND CONCLUSIONS

From the results of the 2001 Canadian Superpave Implementation Tracking Study (C-SITS), as well as continued contact with provincial transportation agencies, the following summary/concluding statements may be drawn concerning Superpave implementation across Canada.

i) The use of Superpave mix design and performance graded (PG) binder specification across Canada is increasing, although at a much slower rate than in the United States. Based on the responses of 41 agencies including the federal, provincial and various municipal governments, it is estimated that over 4.13 million tonnes of Superpave asphalt mix have been placed across Canada between 1994 and 2001.

ii) Despite increased implementation, no responding agencies have fully adopted Superpave in terms of both the PG binder specification and mix design system at this time.

iii) The adoption of the PG binder specification alone has been more rapid and it is estimated that over 28.3 million tonnes of asphalt produced using the Marshall mix design method with PG binder have been placed across Canada between 1994 and 2001. At this time, the Provinces of Quebec and Ontario have fully adopted the PG binder specification, thus many municipal agencies within those provinces also use/specify PG binder. The Atlantic Provinces will shortly adopt the PG binder specification as well, although the Western Provinces have no plans to adopt the specification due to the availability of high quality crude asphalt.

iv) Six of the responding municipalities have constructed Superpave projects and there is a weak, but apparent, relationship between tonnage of Superpave constructed and municipal population.

v) The majority of agencies are currently waiting to observe the performance of their respective Superpave test projects prior to continued implementation. Additional concerns surrounded unresolved technical issues such as the lack of a performance test. Recent and expected research results from NCHRP will likely ease these concerns somewhat.

Overall, it appears that with continued monitoring and experience, it is likely that Superpave will see progressive adoption by Canadian road agencies. C-SHRP will continue to act as technology transfer liaison with the United States Federal Highway Administration (FHWA) and Transportation Research Board (TRB) to ensure that Canadian agencies have the latest information concerning Superpave technology.

REFERENCES

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Federal Highway Administration (1996). *The Superpave System: New Tools for Designing and Building More Durable Asphalt Pavements.* FHWA-SA-96-010. Washington, DC.

Transportation Association of Canada (1997). *Determining the Winter Design Temperature for Asphalt Pavements.* Ottawa, Canada.

Transportation Association of Canada (1999). *Low Temperature Pavement Performance: An Evaluation Using C-SHRP Test Road Data.* Ottawa, Canada.

Appendix A: 2001 C-SHRP Superpave Implementation Survey Form

Canadian Superpave Implementation Tracking Study (C-SITS) – PART I

Refer to the "Survey Questionnaire Instructions" for additional explanation of the required data elements. If information is not available, please indicate with "N/A". **Please attach additional pages with comments if needed.**

Contact Information			
Province:		Telephone No.:	
Agency Name:		Fax No.:	
Agency Contact:		Email:	

Summary Information			
Estimated or Actual Annual Tonnage of Superpave Mix Placed by Your Agency	**Year**	**Full Superpave Design (SP2)**	**Superpave Binder but Marshall Mix Design**
	1992		
	1993		
	1994		
	1995		
	1996		
	1997		
	1998		
	1999		
	2000		
	2001		
	2002		
Has your agency completely adopted the Superpave Mix Design System (as per Asphalt Institute SP1/SP2 or AASHTO)? (Yes or No) When was this done?			
If not, please explain why and whether you have plans to adopt Superpave.			
Overall Constructions Concerns: Has your agency experienced…(Yes or No)	Tenderness in the mix?		
	Difficulty with compaction? (i.e. mix too stiff)		
	Increased segregation?		
	Increased roller pickup?		
	Increased stripping of aggregates?		
In General, have the experienced concerns been remedied through increased experience with Superpave construction? (Yes or No)			
If not, please explain.			
What is the average percentage increase in cost of Superpave asphalt vs. Marshall asphalt that your agency has experienced?			
In your opinion, has the performance of to date justified the extra cost?			

Please Return to Steve Goodman via Fax (613) 736-1395 or email at sgoodman@cshrp.org

Canadian Superpave Implementation Tracking Study (C-SITS) – PART II

Please fill in the following project information for each individual Superpave project.
Refer to the "Survey Questionnaire Instructions" for additional explanation of the required data elements. If information is not available, please indicate with "N/A".

Contact Information			
Province:		Telephone No.:	
Agency Name:		Fax No.:	
Agency Contact:		Email:	

Project Specific Information		
Agency Project No.		
Project Description (Location)		
Station (Beginning/End)		
Number of Paved Lanes		
Design Traffic Volume (ESAL's)		
Design Life (Years)		
Type of Construction (New, Overlay, etc.)		
Part of LTPP or C-LTPP Project (Yes/No)		
Paving Completion Date		
Tonnes of Mix Placed		
Mat Thickness	Top Lift (mm)	
	Middle Lift (mm)	
	Bottom Lift (mm)	
Paving Contractor Name and Average Haul Distance (km)		
Mix Plant Type (Drum/Batch)		
PG Binder Refinery		
PG Binder Supplier		
Binder Modifier Supplier/Type		
PG Grade(s) Used		
PG Grade Selection Criteria		
Nominal Max. Aggregate Size		
Aggregate Gradation (Above, Below or Through the Restricted Zone)		
SP-1 or AASHTO Binder Recommendations Followed? (Yes/No) *Note Exceptions in "Modifications of Superpave Specifications"		
SP-2 or AASHTO Mix Design Followed? (Yes/No) *Note Exceptions in "Modifications of Superpave Specifications"		
Design Gyrations	Ninitial	
	Ndesign	
	Nmaximum	

Canadian Superpave Implementation Tracking Study (C-SITS) - Continued

Compaction Requirements (% of Max. Theoretical Density)	Field Specification Requirements (Minimum/Maximum)	
	Average Measured Field Density	
Were Pay Incentives Used? (Yes/No)	Asphalt Content	
	Gradation	
	Voids	
	Field Density	
	Smoothness	
	Others (Describe)	
Construction Problems (Yes/No) *Discuss detailed problems in "Other Construction Features"	Additional Aggregate Bins Required?	
	Tender Zone During Compaction?	
	Plant or Paving Temperature Changes?	
	Other?	
Is Transverse Cracking Evident?	Age of Pavement (Years)	
	Average Spacing (m)	
Is Rutting Evident?	Age of Pavement (Years)	
	Average Rut Depth (mm)	

Modifications to Superpave Specifications (changes to binder specs, gradation, mix design, etc)
Other Construction Features (problems, unique conditions, environment, etc.)

Please Return via Fax or Email to:

STEVE GOODMAN (613) 736-1395 or sgoodman@cshrp.org

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Canadian Superpave Implementation Tracking Study (C-SITS)

2001 Questionnaire Instructions

One questionnaire form should be completed for each Superpave project. Return the completed forms via fax or email to:

Steve Goodman
C-SHRP Program Manager
2323 St. Laurent Blvd.
Ottawa, ON K1G 4J8
Tel: (613) 736-1350
Fax: (613) 736-1395
Email: sgoodman@cshrp.org

If information is not available for any of the questions contained in the questionnaire, please indicate with "N/A". The following are detailed instructions concerning the questionnaire:

PART I – Summary Information

Province: The province in which the project is located

Agency Name: The agency responsible for the completed road or highway.

Agency Contact: The name of the person who completed the questionnaire.

Telephone/Fax/Email: Contact details of the person who completed the questionnaire so that follow up details may be obtained if necessary.

Estimated or Actual Annual Tonnage of Superpave Mix Placed by Your Agency: Please indicate how much Full Superpave Mix (complete Superpave design using binder specification and gyratory compaction) and/or mix designed with Superpave Binder but using Marshall Mix Design for each year.

Has Your Agency Completely Adopted the Superpave Mix Design System (as per Asphalt Institute SP1 and SP2 or AASHTO)?: Please indicate whether your agency has completely switched from the Marshall mix design method to Superpave and when this was done.

If Not, Please Explain Why and Whether You Have Plans to Adopt Superpave: Please provide a reason why Superpave has not completely been adopted by your agency, and whether you will completely adopt Superpave in the future. If you have an implementation plan, please indicate when it will be initiated.

Overall Construction Concerns: Please indicate whether or not you have experienced the construction problems listed.

In General, Have the Experienced Concerns Been Remedied Through Increased Experience with Superpave Construction?: Please indicate whether continued experience with Superpave construction has alleviated most or all of the construction concerns, or whether they continue to be a problem.

What is the Average Percentage Increase in Cost of Superpave Asphalt vs. Marshall Asphalt That Your Agency Has Experienced?: Give an average percentage increase in cost (if any) associated with designing, mixing and constructing Superpave asphalt.

In Your Opinion, Has the Performance To Date Justified The Extra Cost?: Please indicate whether you feel the performance of the Superpave mix to date has justified (or will justify) the extra cost.

PART II – Individual Project Information

Agency Contact Information: Same as Part I

Agency Project No.: The agency's project number as indicated on their construction plans.

Project Description (Location): A written description of the project location. (Ex. Highway 2, between Main St. and Local Rd.)

Milepost (Beginning/End): Identify the beginning and end milepost for the project.

Number of Lanes: Indicate the number of lanes paved in each direction.

Design Traffic Volume (ESAL's): List the traffic level used in the HMA mix design. If the traffic level used for the pavement thickness design is different, please indicate both design levels.

Design Life (Years): List the number of years associated with the Design Traffic Volume.

Type of Construction: Is the pavement placed on a new granular base, recycled granular base, overlay of an existing asphalt pavement or concrete pavement (please differentiate), etc? Please indicate the milling thickness if appropriate.

Part of the LTPP or C-LTPP Projects?: Indicate if the project was built as part of the US or Canadian Long Term Pavement Performance projects and is being continually monitoring for performance.

Paving Completion Date: Indicate the date that the top lift was placed and compacted.

Tonnes of Mix Placed: List the total approximate number of metric tonnes of Superpave mix placed during the project (all lifts).

Mat Thickness: List the thickness of each Superpave lift placed.

Paving Contractor Name and Average Haul Distance (km): Indicate the name of the paving contractor or subcontractor and the average haul distance from the asphalt mix plant to the paving project.

Mix Plant Type (Drum/Batch): Indicate the type of mix plant used by the contractor or subcontractor.

PG Binder Refinery: Indicate the name of the primary refinery of the PG asphalt cement. If multiple sources were used, please indicate secondary sources in the "Other Construction

PG Binder Supplier: If the refinery did not directly supply the PG asphalt cement, indicate the local supplier. Please also indicate the approximate distance

Binder Modifier Supplier/Type: Indicate the name of the supplier(s) and type of modifier used if applicable.

PG Grade: List the Superpave performance-graded binder(s) used on the project. Indicate the location of different binders (lower lifts, etc).

PG Grade Selection Criteria: How was the PG binder grade determined (LTPPBind, Superpave software, etc.)? Which low temperature algorithm was used (SHRP, LTPP or TAC/Robertson)? Was the high temperature grade "bumped" to accommodate slow moving or stopped traffic? If so, by how many grades?

Nominal Maximum Aggregate Size: Indicate the nominal maximum aggregate size of the mix used. By definition, nominal maximum aggregate size is one sieve size larger than the first sieve to retain more than 10 percent of the aggregates by mass. Please note any exceptions or if multiple gradations were used (lower lifts, etc).

Aggregate Gradation: Indicate if the aggregate gradation curve plotted above (fine mix), below (coarse mix), or through the restricted zone as outlined in the Asphalt Institutes SP-2.

SP-1/AASHTO Binder Recommendations Followed?: If the binder specifications outlined in the Asphalt Institute Manual SP-1 and the AASHTO Provisional Standards were followed completely, indicate "Yes". If the agency modified these procedures to meet local conditions, indicate "No" and note the changes in the "Modifications to Superpave Specifications" section.

SP-2/AASHTO Mix Design Recommendations Followed?: If the mix design specifications outlined in the Asphalt Institute Manual SP-2 and the AASHTO Provisional Standards were followed completely, indicate "Yes". If the agency modified these procedures to meet local conditions, indicate "No" and note the changes in the "Modifications to Superpave

Design Gyrations: List the number of design gyrations used with the Superpave gyratory compactor for the mix design (initial, design and maximum).

Compaction Requirements: List the minimum and maximum theoretical density (% Rice) specified by the agency as well as the average measured field density during construction (% Rice).

Were Pay Incentives Used?: Indicate if pay incentives or disincentives (pay factors) were specified for the project. Indicate "I" for incentives (bonuses) or "D" for disincentives (penalties).

Construction Problems: Indicate construction problems encountered during the project that could be attributed to the Superpave mix. Please provide detailed descriptions of the problems encountered in the "Other Construction Features" section.

Is Transverse Cracking Evident?: If post construction transverse cracking has been observed on the finished pavement, indicate the age of pavement at which the cracking first appeared (months or years) and the average spacing between transverse cracks (m).

Is Rutting Evident?: If post construction rutting has been observed on the finished pavement, indicate the age of pavement at which the rutting first appeared (months or years) and the average rut depth (mm).

Modifications to Superpave Specifications: Indicate any changes to the Superpave recommendations outlined in the Asphalt Institute Manuals SP-1 and SP-2, or to the specifications outlined in the AASHTO Provisional Standards used by the agency or contractor to adapt the Superpave system to local conditions.

Other Construction Features: Provide detailed explanation of any problems encountered while constructing the Superpave project or any other unique conditions that may affect the long term performance of the pavement.

Thank you for your participation