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Date: June 10, 2004

To: Magdy Mikhail

From: Project Research Team

Project: 0-4824

Tech Memo: 4824-1

GUIDELINES FOR SELECTING ASPHALT MIXTURES AND EVALUATION OF POLYMER-MODIFIED MIXES

Project Survey

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1 Introduction

The purpose of the survey was (1) to gather information required for the selection of asphalt mixtures (HMA) and polymer modified binders (PMBs) to be used in TxDOT research study Project 0-4824 and (2) to identify and bring together current practices, opinions and applications towards the development of guidelines for the selection of HMA and PMBs in Texas.

The survey as submitted is included in Appendix A. A total of 27 responses to the survey were received. Responders are shown in Table 1. Responses were received from most of the Texas districts. Districts that did not respond include:

- Amarillo
- San Angelo
- Abilene

The survey asked specific questions relating to different aspects of asphalt mixture design, cost and performance. The use of polymer-modified binders was also addressed. This document outlines the responses obtained, summarized in the form of a general consensus as determined based on the survey responses.

At the offset it should be mentioned that the survey at best reflects a general trend. Responders did not answer each and every question posed. There were many gaps in the responses; hence the "general consensus" parameter as plotted is low overall for most of the questions posed. The ranking of the elements of each question posed should therefore be considered relatively.

2 HMA used in the districts

Figure 1 shows the different asphalt mixes used in Texas. The majority of the districts use the traditional dense graded Texas Type mixes. The SMA, Superpave and CMHB mixes are also popular. Three of the survey responders cited other mixes used in their districts including asphalt roof tab (10%) (Dallas, Dallas), asphalt stabilized base (Beaumont, Beaumont) and PMSC in Forth Worth, Forth Worth.

The point was made that CMHB-F and CRM-HMAC are similar mixes. The responder from the Paris district noted that most hot mix used in that district contains bottom ash instead of field sand.

3 HMA selection influence factors

Figure 2 shows the general consensus regarding factors influencing the selection of HMA for use in the districts. The majority of the responses cited district policy, TxDOT research, past performance experience and engineering judgment as influencing selection decisions, the latter ranking the highest. Research outside of Texas, experimentation and directives from Austin scored low. No survey responses selected mechanistic design, NAPA guidelines or consultants as influence factors.

4 HMA selection criteria

Figure 3 summarizes the district responses regarding HMA selection criteria. Responders were asked to rate each criterion as being of low importance, important or very important. The general consensus is that traffic is the most important criterion to be used for mix selection. Other very important criteria include underlying pavement structure, service life, existing pavement condition and safety. Temperature, rainfall and road geometry were generally rated as being of low importance.

One of the responders made the point that they would have ranked service life higher if they had physical evidence that a mix lasts as long as it should. The point was made that low permeability of mixes is very important if the underlying pavement structure is moisture susceptible, hence rainfall becomes an issue to consider.

5 Adequacy of HMA laboratory mix designs

The survey asked responders to indicate their opinion of laboratory mix design procedures for the different mixes used in Texas. This question was included in the survey since designers may be biased in their selection of a specific asphalt mix based on their opinion of the complexity of designing the mix in the laboratory. Figure 4 summarizes the general consensus regarding the adequacy of HMA laboratory mix designs. Overall the general opinion is that each of the laboratory designs for the different mixes survey was adequate. A high percentage of the responders point out the Texas Type A and B base mixes are poorly designed. Part of the problem with the base mix design is that 7/8" material is scalped to make laboratory mold specimens and does not fully represent material being placed. Responders pointed out that more detail is needed concerning the use of fibers with SMA and concern was expressed over the creep test reliability for CMHB. It should be noted that many mix designs (QC/QA and SMA for example) are done by contractors and consultants and only verified by districts labs.

6 HMA performance expected

The responders were asked to state which HMA mixes would in their opinion alleviate specific performance problems relating to rutting, fatigue and drainage problems as well as functional issues such as noise, skidding and splashing. Figure 5 and Figure 6 summarize the responses received. This reflects on the responder's opinion of a specific mix relating to performance experienced and may influence mix selection decisions.

Overall the responders have a positive opinion of the rutting and cracking resistance potential of the mixes cited. The responders also have a positive opinion regarding the skid resistance of the different mixes, which may be more related to the aggregates used in Texas. As expected, the

PFC mixes rank positively regarding the function requirements. Responders also point out that a smoother ride can be expected from PFC mixes.

7 HMA problems experienced

Figure 7 shows HMA problems experienced with the cited mixes in terms of rutting, fatigue and cracking whereas Figure 8 shows problems experienced in terms of flushing, segregation, raveling and stripping. A cause for concern should be the high consensus regarding rutting, fatigue and reflective cracking of Type D mixes in Texas as well as the high consensus regarding reflective cracking and fatigue of Type C mixes. The fatigue and cracking problems with these mixes is known given that their design is more focused on alleviating rutting - resulting in the use of lower binder contents and stiffer binders.

Segregation appears to be a problem for all mixes and is probably due to placement procedure rather than production and hauling of the mixes. Stripping of Type D mixes is emphasized.

8 Ranking of HMA performance experienced

The districts were asked to rank their experience regarding the performance of mixes used in Texas with respect to rutting, fatigue-, reflective- and longitudinal cracking as well as noise, skid and splash.

Figure 9 shows the responses with respect to resistance to rutting. Overall it appears that rutting is not a problem for the mixes cited. Mixes with stiffer (PG-76) binders have superior rutting performance. Poor rutting performance is noted for Type D mixes with PG 64 binders. Poor rutting performance is also reported for Type F mixes. As expected, superior rutting resistance is shown for SMA mixes.

Figure 10 shows the consensus regarding the fatigue resistance of the mixes. While the general consensus is that fatigue resistance of mixes appears to be adequate, the percentage of responses stating poor fatigue resistance is relatively high for the Texas Type mixes regardless of binder stiffness. This is also emphasized in Figure 11 that indicates reflective cracking is a problem for these mixes and albeit to a lesser extent, longitudinal cracking as shown in Figure 12.

As far as functional requirements are concerned the mixes perform as expected i.e. excellent splash and noise reduction for PFC mixes and adequate performance of the other mixes as indicated in Figure 13 (Noise reduction experienced), Figure 14 (Skid resistance) and Figure 15 (Splash reduction). As expected, splash is a problem on the dense graded Texas Type mixes.

9 HMA construction cost

Figure 16 shows the survey responses to HMA construction cost. For the more commonly used mixes the construction costs are moderate whereas the cost of SMA, PFC, CRM HMAC and to a lesser degree Superpave is high.

Construction costs vary by district. The point was made that the El Paso District, historically, has always paid a higher than statewide average for all mixes. Although a better indication of construction costs can be got from other sources the question was posed to get an indication of the responders opinion of relative mix cost as it may reflect on selection tendencies.

10 HMA maintenance cost

Figure 17 shows the district response regarding maintenance costs for the cited mixes. In general, maintenance costs are rated as being moderate. Some districts noted that their Superpave mixes have not been down long enough to determine maintenance costs. Maintenance costs for SMA are rated as low but this could also be because the use of these mixes in Texas is still relatively new.

El Paso associated high maintenance costs for Type D and CMHB-C mixes mentioning that this is tied to thin layers over thick layers of suspect base.

11 Mix applications

Figure 18 and Figure 19 show the different applications for the mixes. Figure 18 lists the mixes used for surfacing, level-up, bases and for use as overlays. Interestingly, all of the mixes cited (except the base mixes) have been used as overlays. A relatively high percentage of SMA is used as base course.

Figure 19 indicates the use of the mixes at intersections, as curb and gutter applications, on steep slopes and as bond breakers. PFC mixes do not appear to be used at intersections or for curb and gutter applications.

12 Traffic considerations

The districts were asked to identify which mixes would be appropriate for different traffic levels i.e. low (less than 1 million design ESALs), moderate (1 – 10 million design ESALs) and high (> 10 million design ESALs). Figure 20 shows the responses to the question. In some cases more than one traffic level was suggested for a particular mix. While this is true, the results were filtered to indicate the highest traffic level that may be considered for any particular mix.

The results of the survey indicate that traffic level is related to binder stiffness used i.e. the higher the design traffic the stiffer the binder used with a mix. SMA, PFC, CRM HMAC and Superpave mixes are generally used for high design traffic.

13 HMA construction experience

Figure 21 shows the experience of the district engineers and contractors with construction of listed mixes. This question was answered by the majority of the responders. As expected, the districts have a lot of experience with the Texas Type B, C and D mixes. This is not the case with most of the other mixes listed where the districts have little or no construction experience.

Consideration of mixes other than the Texas Type mixes as part of selection guidelines will need to be weighted against construction experience or the cost of ensuring this. It suggests a reliability analysis to assess the risks associated with the different mixes.

14 HMA compaction experience

Figure 22 shows the district's response regarding the relative ease with which the listed mixes compact in the field. As expected, harder (stiff binders) and coarser mixes are more difficult to compact. The coarser the mix the harder it is to achieve density especially in the cold seasons when open graded type mixes tend to cool down quickly. Superpave mixes in Texas are generally designed below the reference zone. These mixes are particularly coarse. There are no density requirements for PFC mixes.

15 HMA additives

Figure 23 shows the use of lime and liquid anti-strip additives with the listed mixes. These additives and in particular lime is used for most mixes in Texas. Liquid anti-strip is not used for mixes with crumb rubber modifier.

Some districts (such as Childress) require the use of lime for all mixes. The Pharr district specifies a minimum of 1 percent and a maximum of 1.5 percent lime on all Type D and B designs. The Tyler district does not specify lime or liquid anti-strip except for SMA and PFC mixes.

Liquid anti-strip is sometimes used in addition to lime to meet the requirements of Tex 531-C. Atlanta points out that the use of lime has been detrimental to some of their mixes especially when Sawyer/Apple sandstone is used. They point out that the use of lime in these cases required a higher AC content.

16 HMA service life

Figure 24 shows the districts experience with surfacing service life. They were asked to rank the service life of the mixes as low (0 – 5 years), adequate (5 – 10 years) or excellent (> 10 years). The figure indicates that most of the mixes offer adequate life. Type F mixes have low service life and SMA mixes generally ranked as having excellent service life.

Responders have pointed out that overlays are designed to last about 10 years and that although crack sealing or seal coat may be required sooner, these surface layers are generally not rehabilitated.

The Atlanta district noted that Type C and D mixes with sandstone generally have lower service lives compared to these mixes with aggregates other than sandstone.

Service life is dependent on the traffic volume.

17 HMA modifiers

Figure 25 shows which modifiers have been used with the listed mixes in Texas. The most commonly used modifier is SBS followed by SBR Latex and then Tire Rubber. Elvaloy is increasing being considered, particularly for the dense graded mixes. Only Beaumont reported the use of EVA with Type C mixes.

Modifiers are generally not used in the Paris district. The Childress district requires SBS in all mixes. They point out that they tried Elvaloy a couple of years ago, but that it didn't perform well. The Atlanta district reports compatibility issues with latex in 1990's. El Paso only recently began to require an additive in the asphalt. Prior to this it was the only district in the state using a PG 76-16 produced without an additive on all mixes and construction projects. The Tyler district normally specifies SBR or SBS for mixes with PG 70-22 binder only. Atlanta will select a modified binder if there is a possibility that siliceous gravel will be used in the mix.

18 Performance benefits of PG modifiers

The districts were asked to list which of the modifiers improved mixture performance in terms of:

- Rutting resistance
- Fatigue resistance
- Aging resistance
- Reflective cracking retardation
- Long term durability
- Improved bonding/adhesion

Figure 26 shows the district's response. From the figure it can be seen that SBS, SBR Latex and tire rubber were listed as modifiers improving the listed performance parameters. Elvaloy and EVA ranked low. Tire rubber ranked high in terms of mitigating reflective cracking and improving long term durability and bonding.

The Atlanta district made the point that even though various sources have indicated the positive benefits of modifiers, mixes are often designed and produced with low binder contents, minimizing this potential.

19 PG Modifier content

Question 20 of the survey asked whether modifier content was specified or based on that to obtain PG grade or both. Figure 27 summarizes the district's responses to the question. From the figure it can be seen that in general the modifier content is not specified for the listed modifiers although there are cases where it was specified for SBR latex, SBS and tire rubber.

Notwithstanding, tire Rubber content is specified for PFC with CRM. For mixtures with tire rubber, the binder must meet specifications with some rubber content but that specific content is not known prior to the binder design.

20 Pavement structure

The districts were asked to indicate which of the listed asphalt mixes would be appropriate for layers as part of 6 different pavement structure options as shown in Table 1. The results of the survey are shown in Figure 28 through Figure 30. This question was well answered and will serve as an excellent reference in the development of the guidelines. The Atlanta district pointed out that asphalt layers could be considered for pavement structure 3 (over granular base) if the underlying layer was not moisture susceptible and in good condition. It was noted that the Superpave 12.5 mm mix could be use as bond breaker between two rigid layers when produced at higher AC content. Water tightness of concrete surface should be a consideration in determining what mix to place directly over concrete pavement (structure 6).

Table 1. Pavement Structures

New construction: 1: 1. AC surface 2. AC level-up 3. AC base course Granular layers	New construction: 2: 1. AC surface 2. AC base course Granular layers	New construction: 3: 1. AC surface Granular layers (flex base, stabilized layers and subgrade)
New construction: 4: Concrete pavement 1. AC base course Granular layers	Rehabilitation: 5: 1. AC surface Old flexible pavement	Rehabilitation: 6: 1. AC surface Old concrete pavement

Table 2. Survey Responders

#	Contact	District	City
1	Abbas Mehdibeigi	Dallas	Dallas
2	Al Aramoon	Dallas	Mesquite
3	Albert Pardo	Corpus Christi	Corpus Christi
4	Bobby R. Jones	Paris	Paris
5	Carl W. Ramert	Yoakum	Yoakum
6	Darlene C. Goehl	Bryan	Bryan
7	Darwin Lankford	Childress	Childress
8	Gerardo M. Carmona	San Antonio	San Antonio
9	Jim Black	Wichita Falls	Wichita Falls
10	Lenny Bobrowski	Austin	Austin
11	Luis Carlos Peralez	Pharr	Pharr
12	Thomas Lev	Houston	Rosenberg
13	Michelle Milliard	Houston	Angleton
14	Miles R. Garrison	Atlanta	Atlanta
15	Bill Brudnick	Houston	Houston
16	Raymond B. Guerra	El Paso	El Paso
17	Richard K. Boles	Paris	Lufkin
18	Ronald F. Hatcher	Childress	Childress
19	Ricky L. Walker	Lubbock	Lubbock
20	Steve Sell	Beaumont	Beaumont
21	William Willeford	Tylor	Tylor
22	Richard Walker	Brownwood	Brownwood
23	Rene Soto	Laredo	Laredo
24	Tomas Saenz	El Paso	El Paso
25	Kathryn (KC) Evans	Odessa	Odessa
26	Richard S. Williammee	Forth Worth	Forth Worth
27	Chris Starr	Waco	Waco

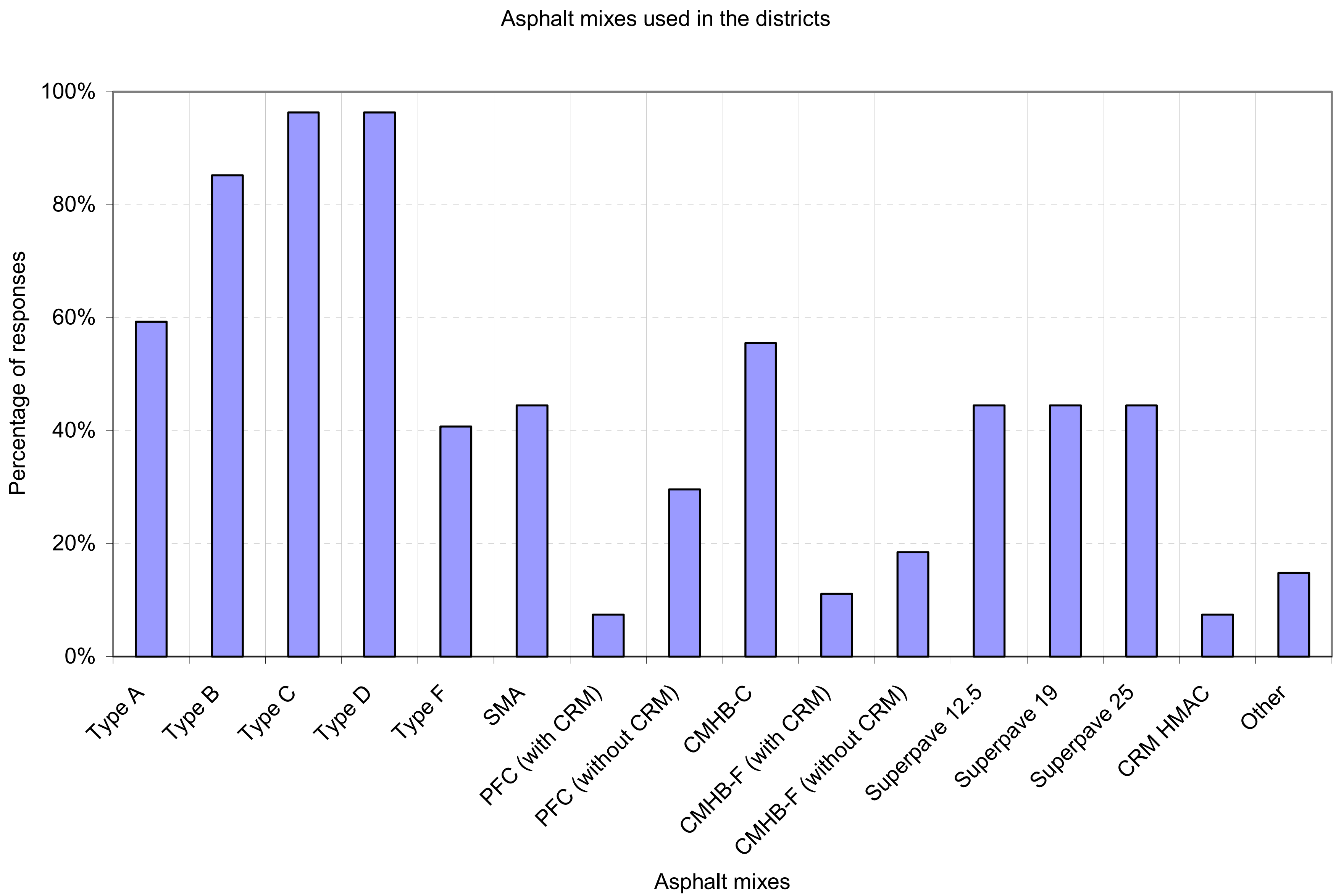

Figure 1. Asphalt mixes used in the districts

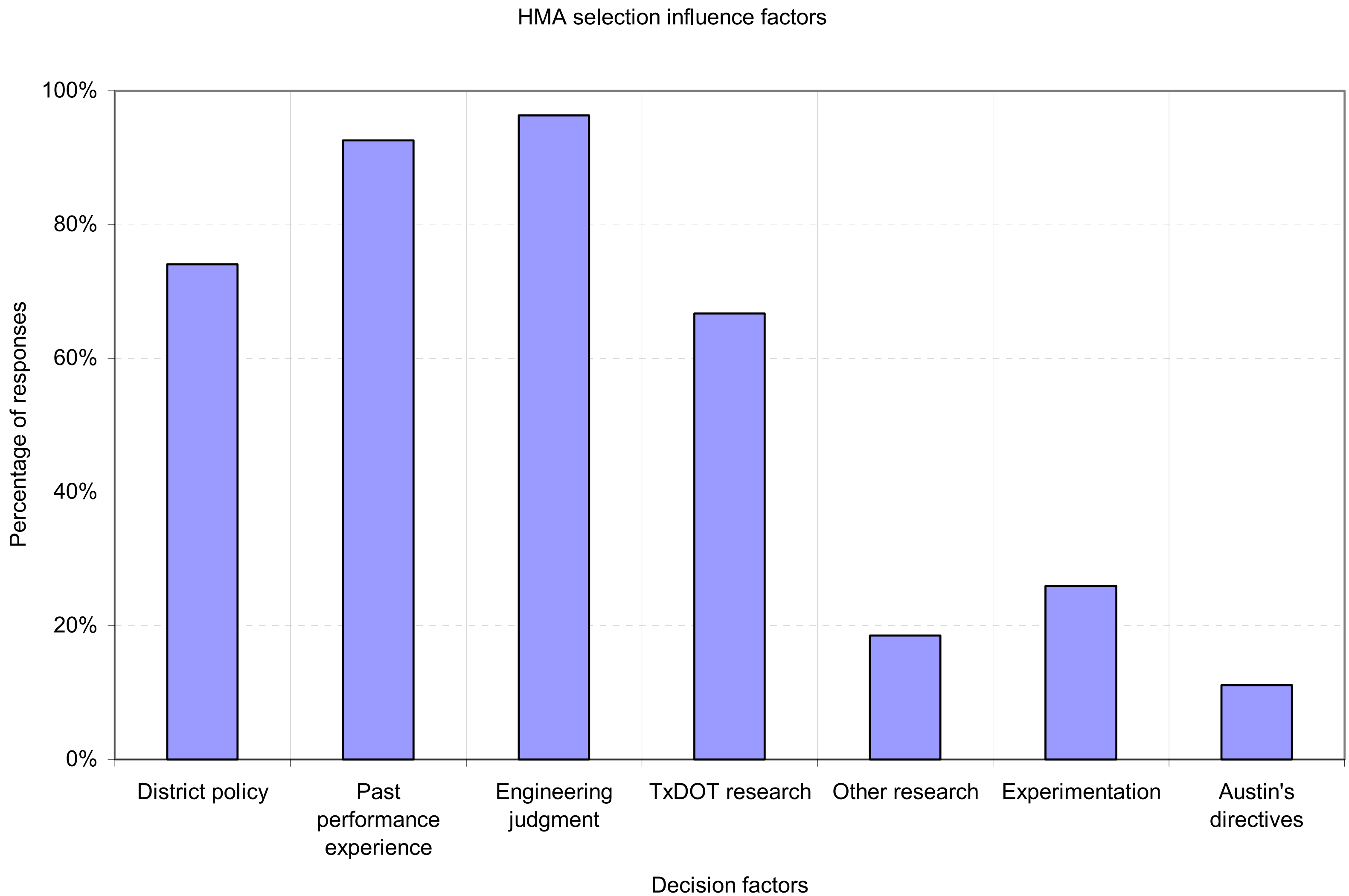

Figure 2. HMA Selection Influence Factors

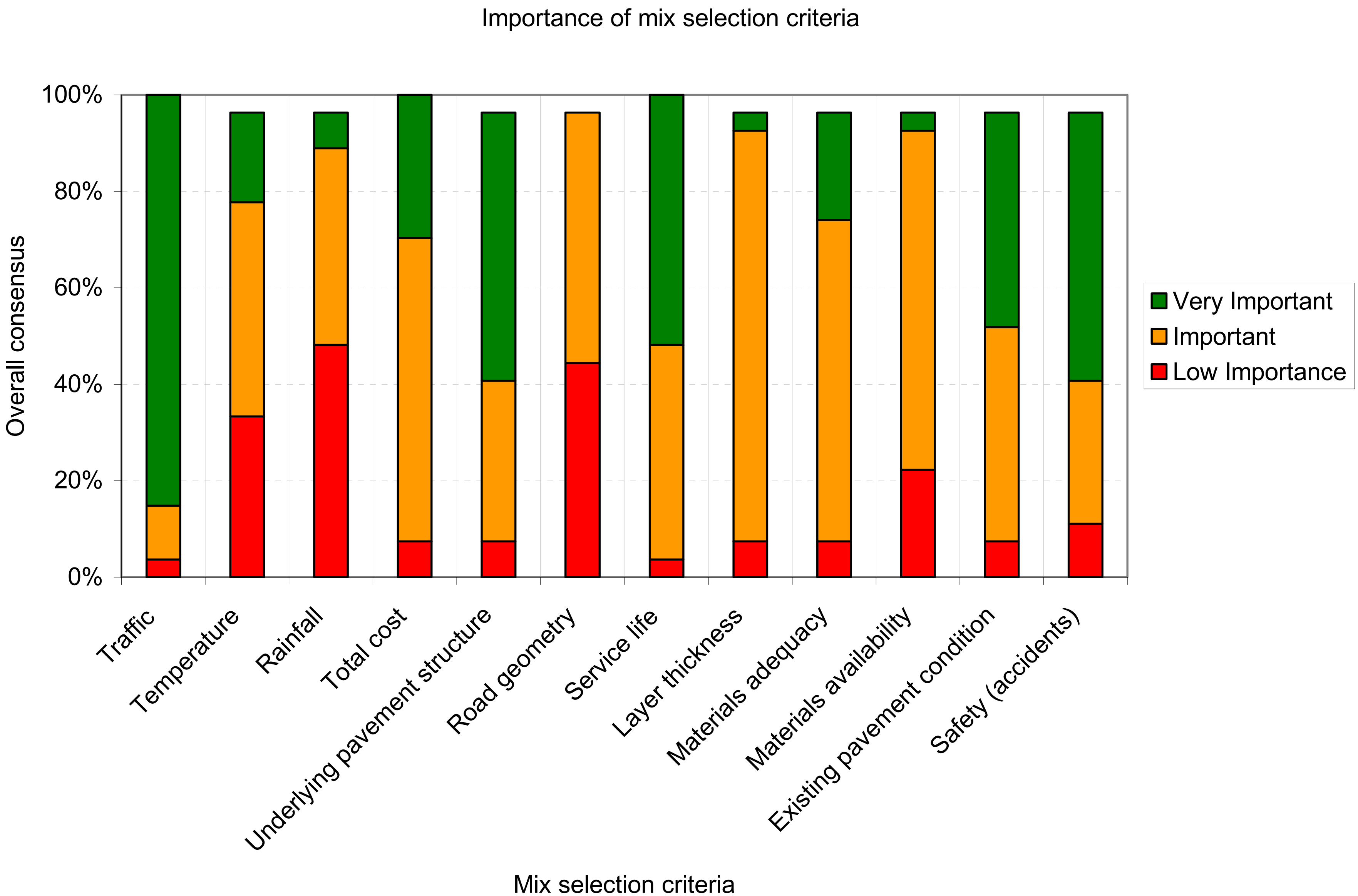

Figure 3. Importance of Mix Selection Criteria

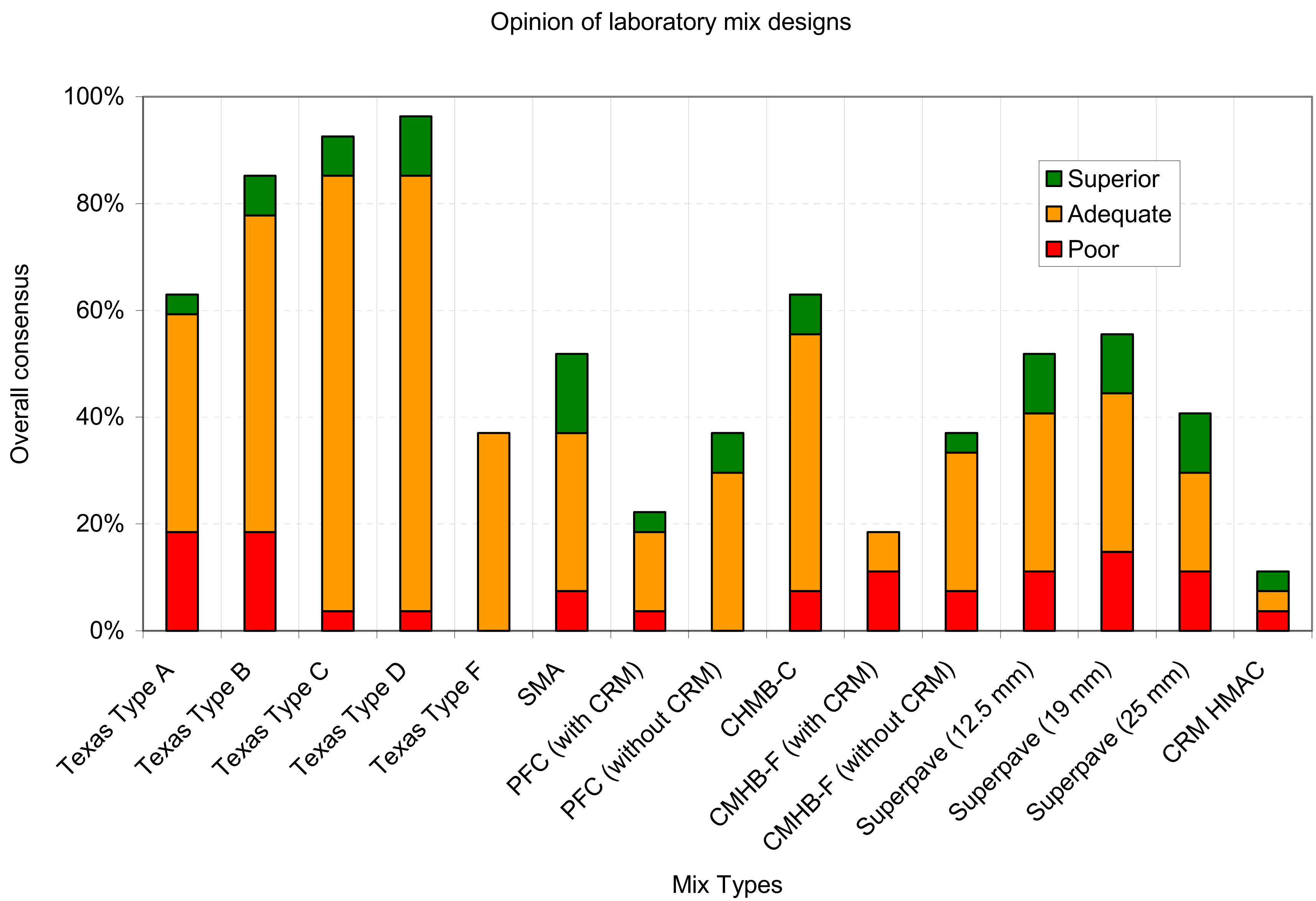

Figure 4. Opinion of Laboratory Mix Design

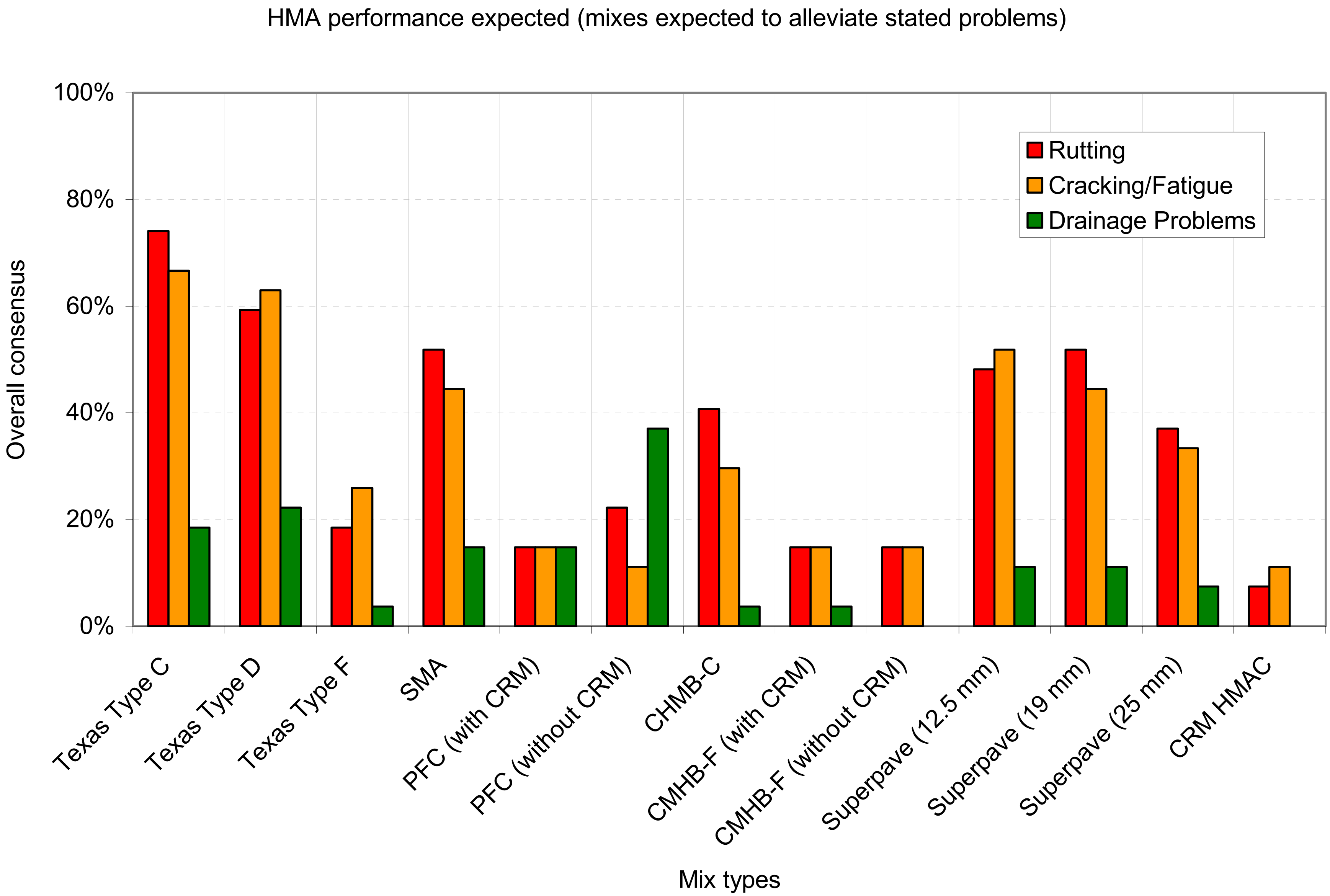

Figure 5. HMA Structural Performance "Expected"

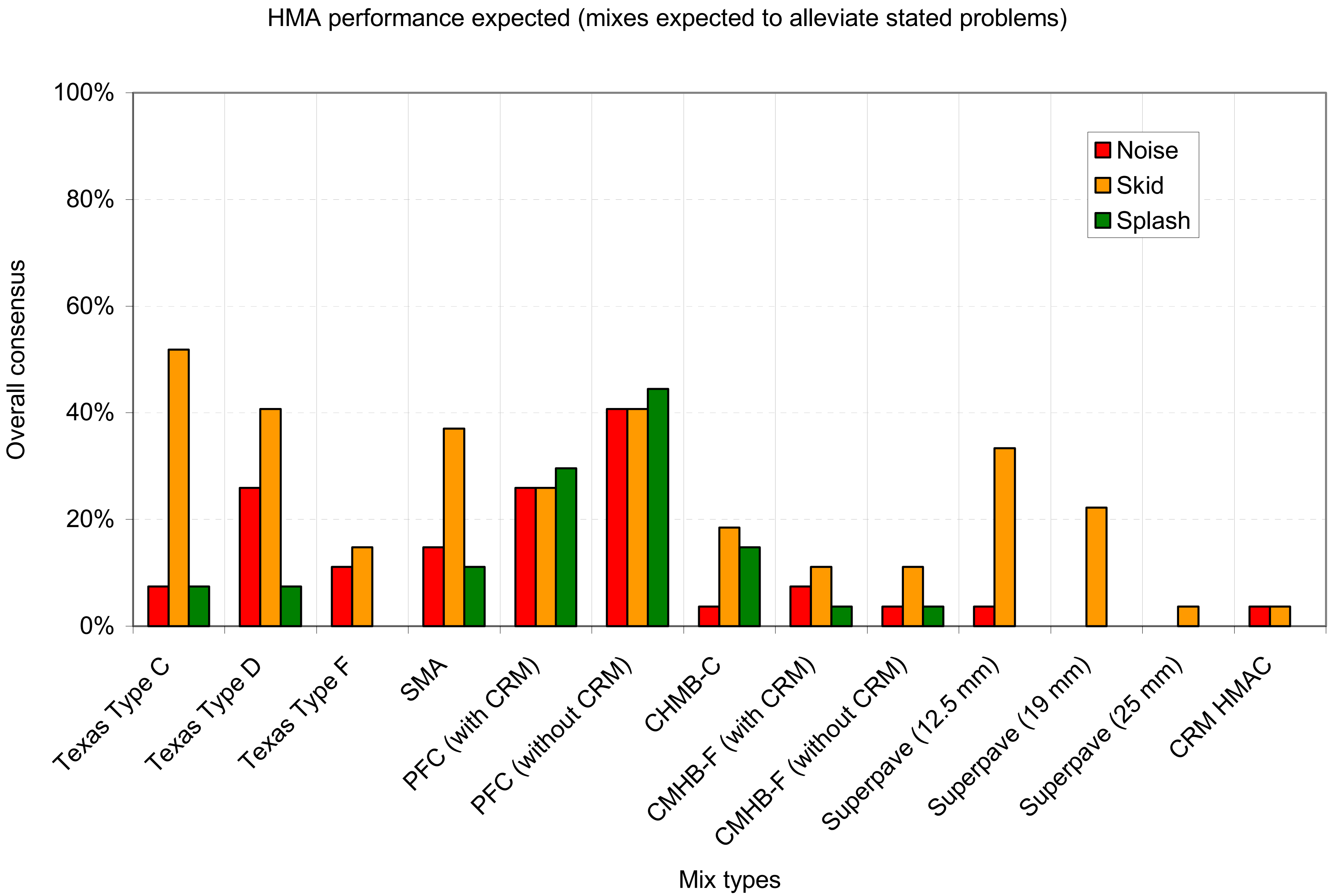

Figure 6. HMA Function Performance "Expected"

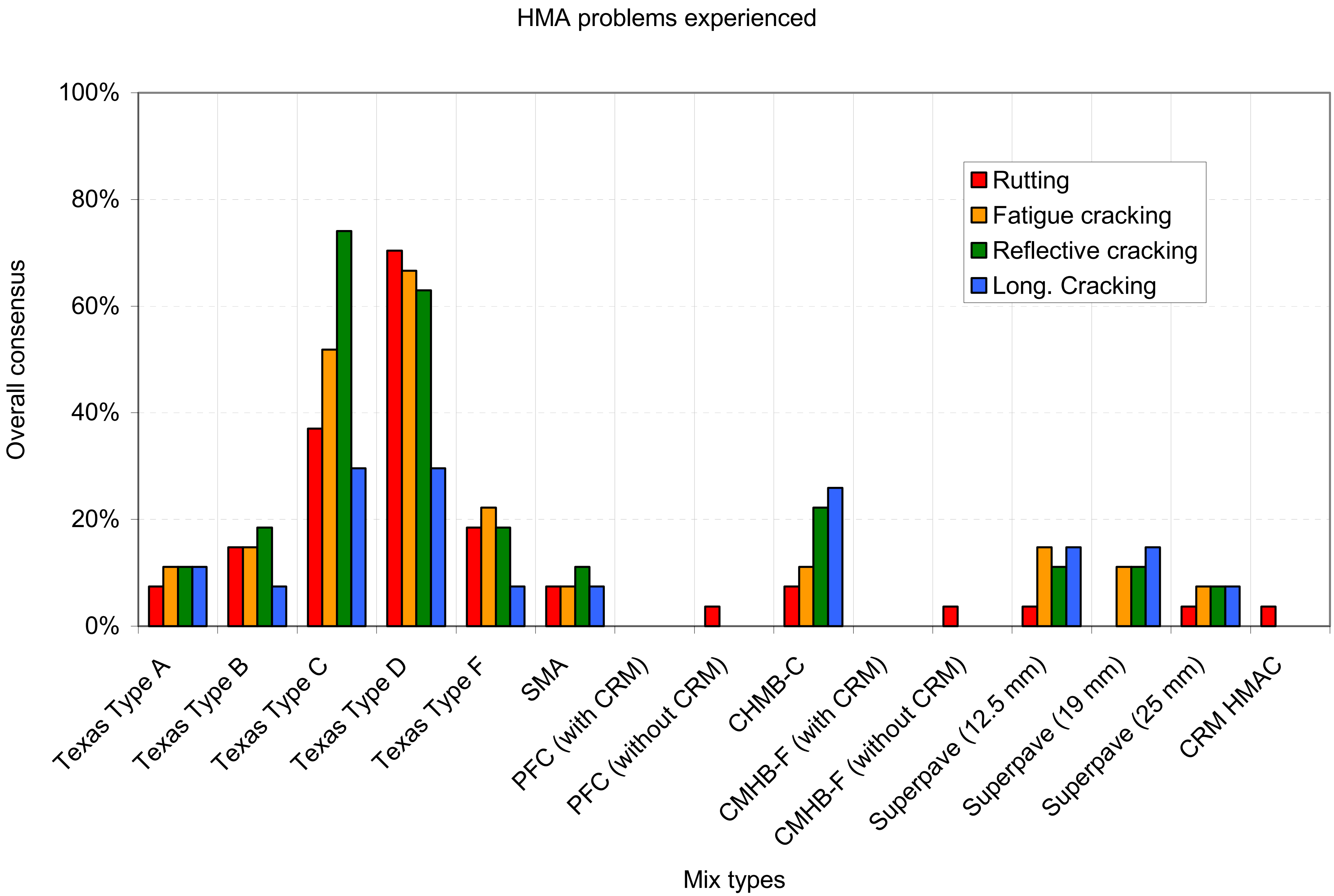

Figure 7. HMA Problems Experienced

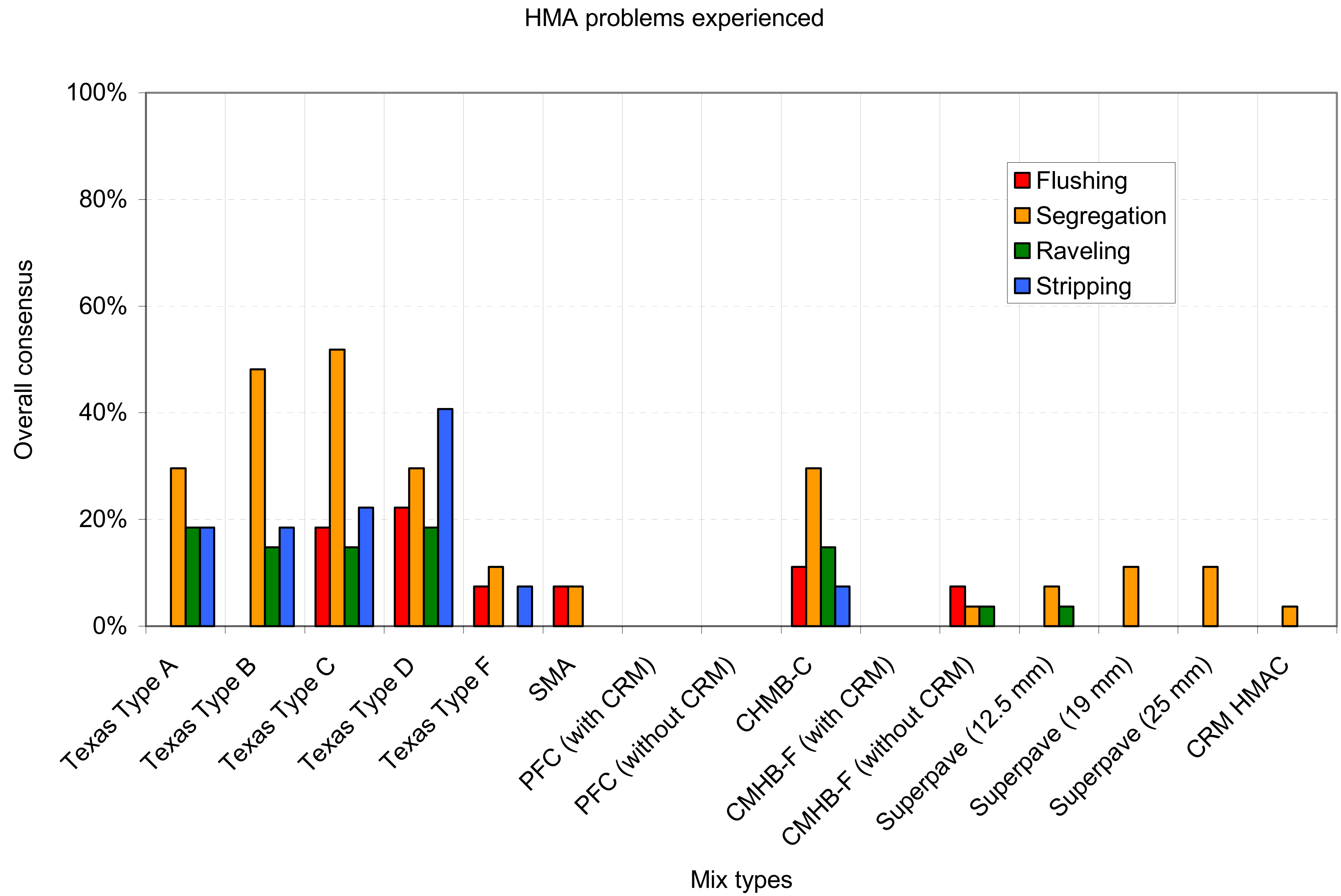

Figure 8. HMA Problems Experienced (Cont.)

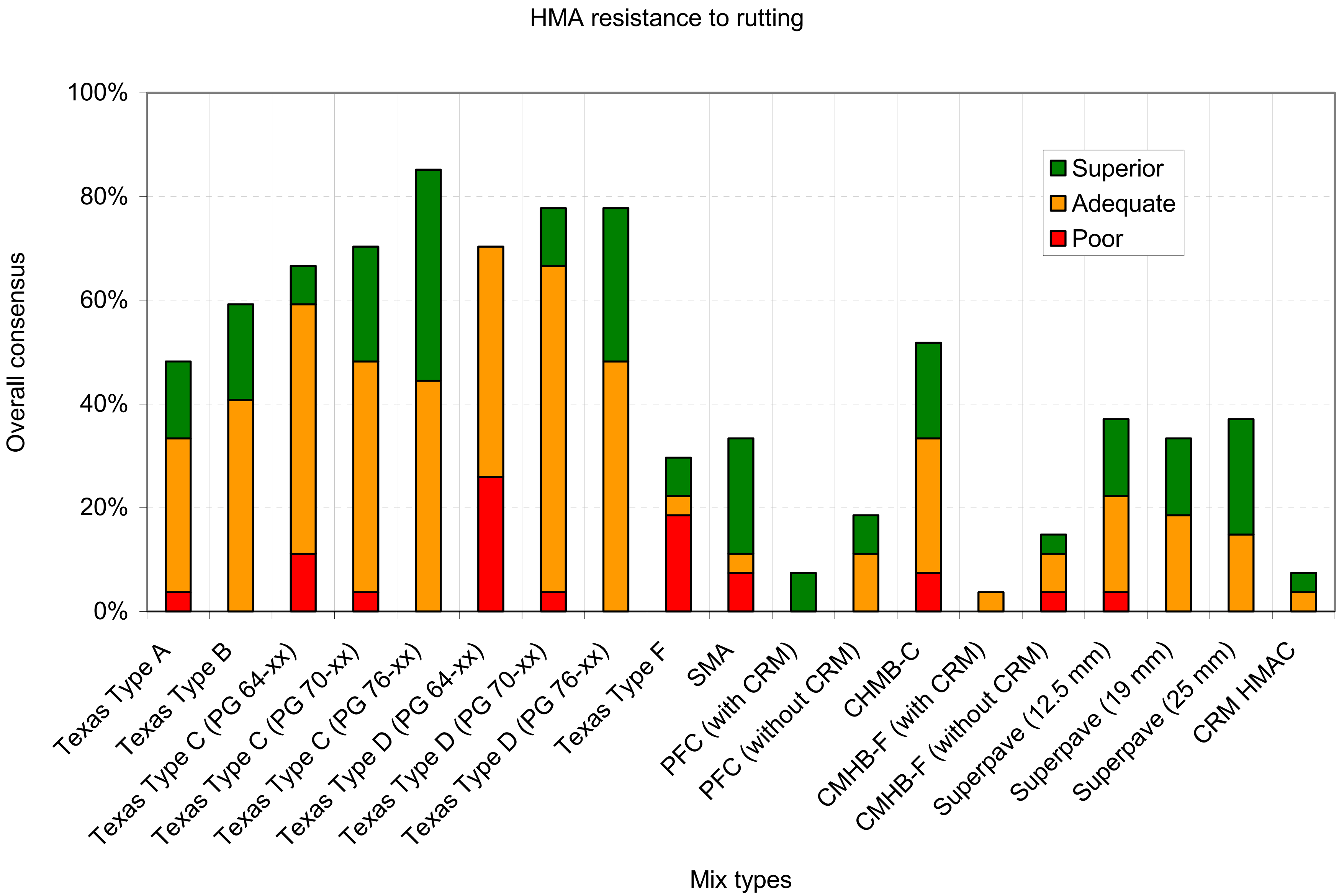

Figure 9. Resistance to Rutting

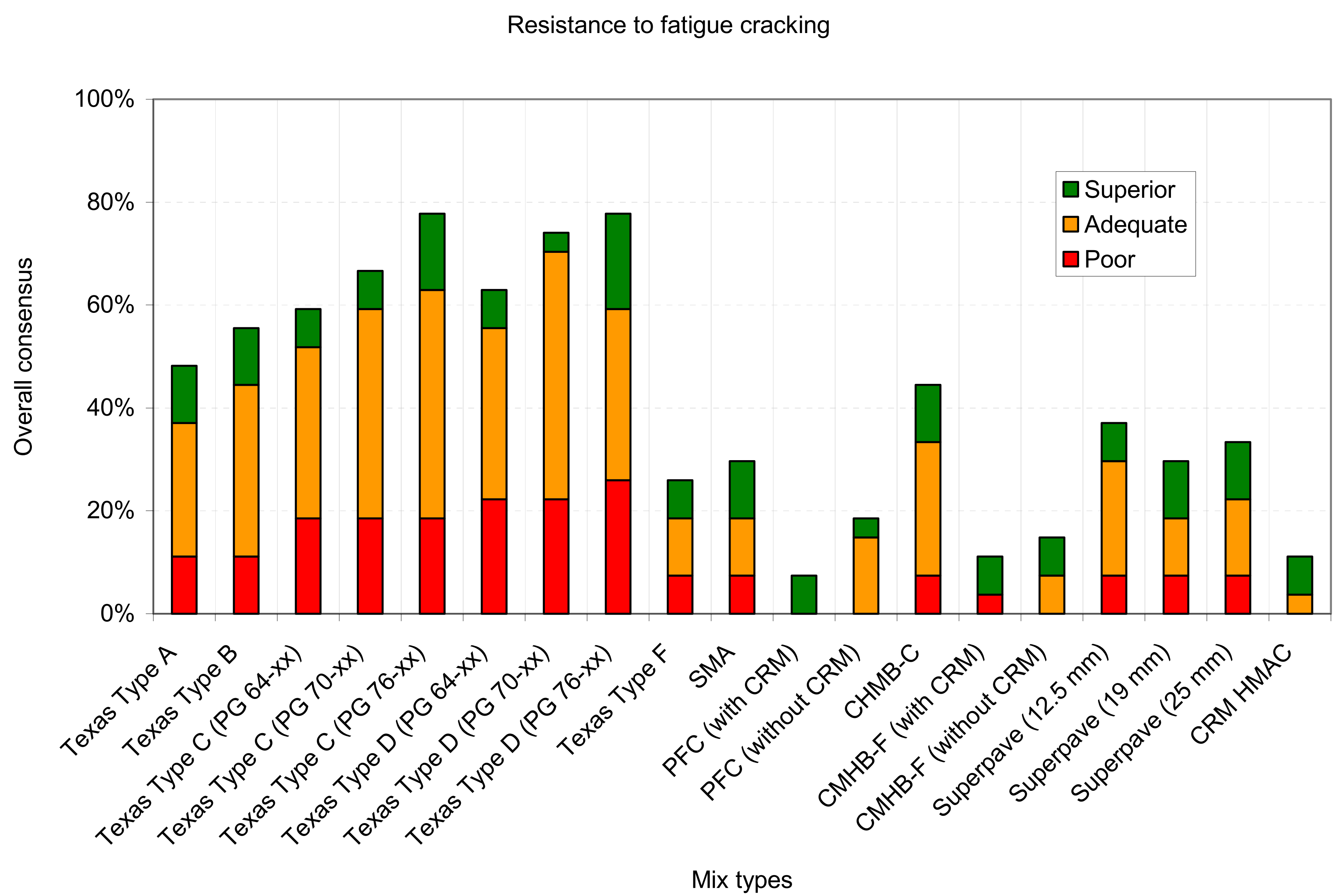

Figure 10. Resistance to Fatigue Cracking

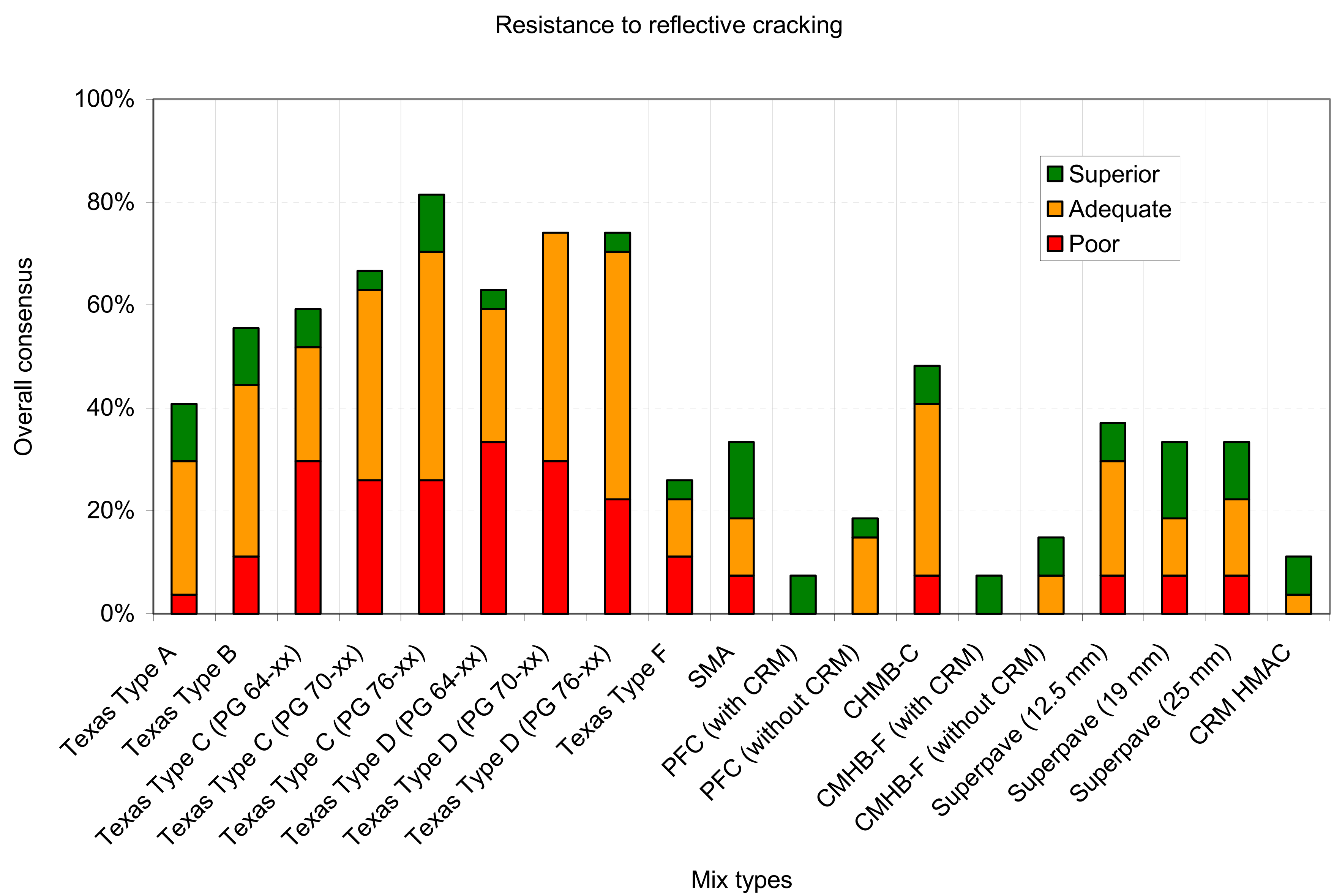

Figure 11. Resistance to Reflective Cracking

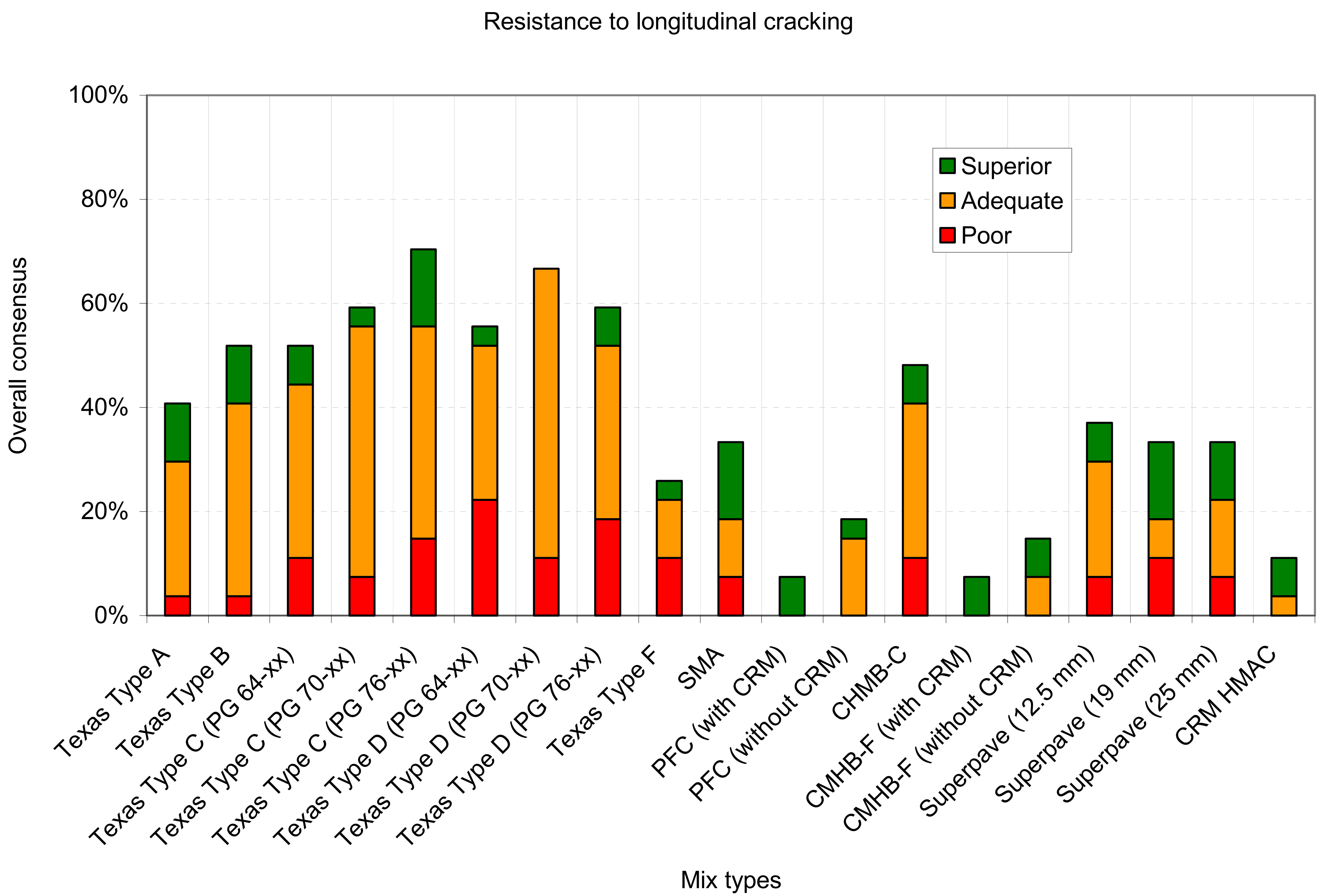

Figure 12. Resistance to Longitudinal Cracking

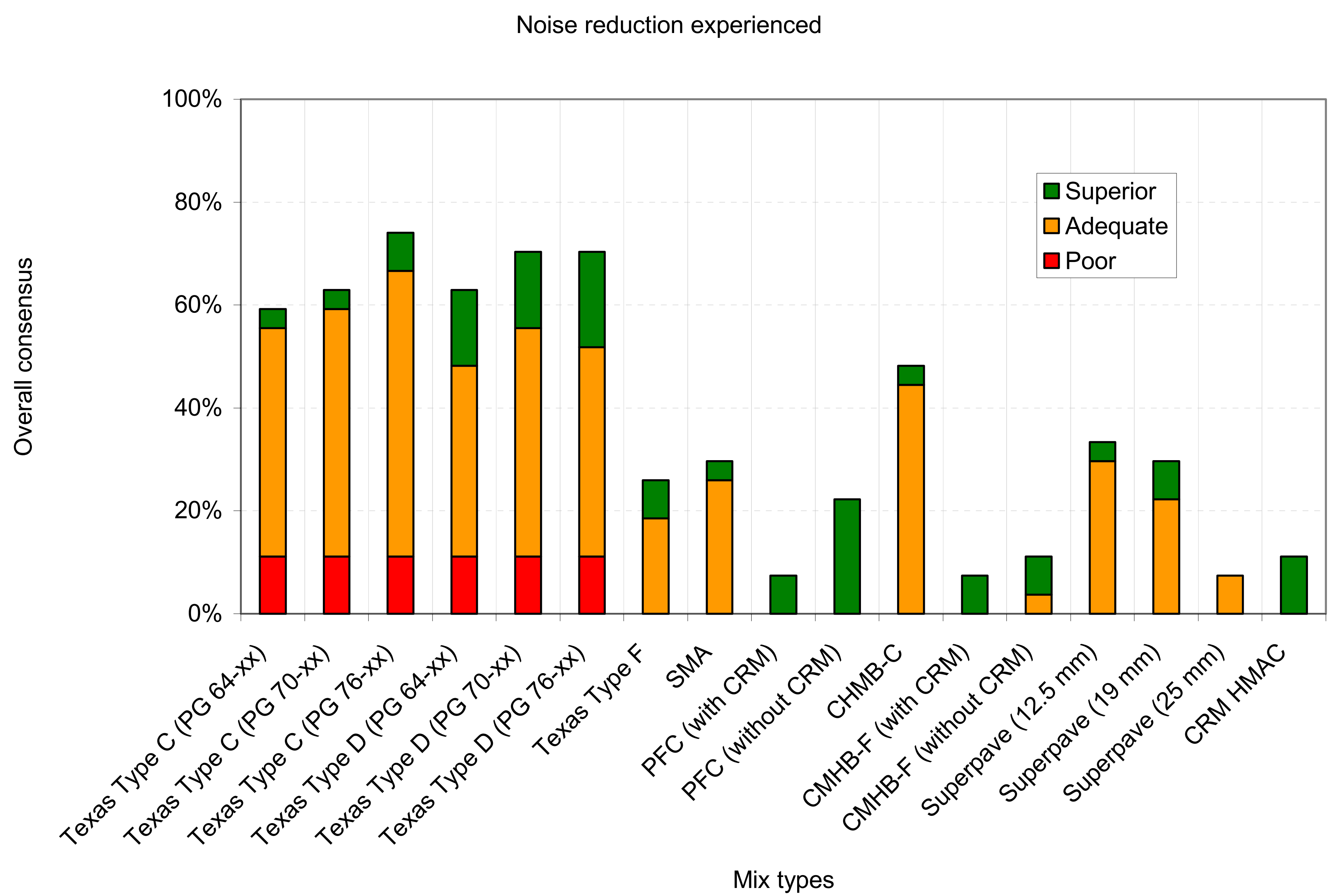

Figure 13. Noise Reduction Experienced

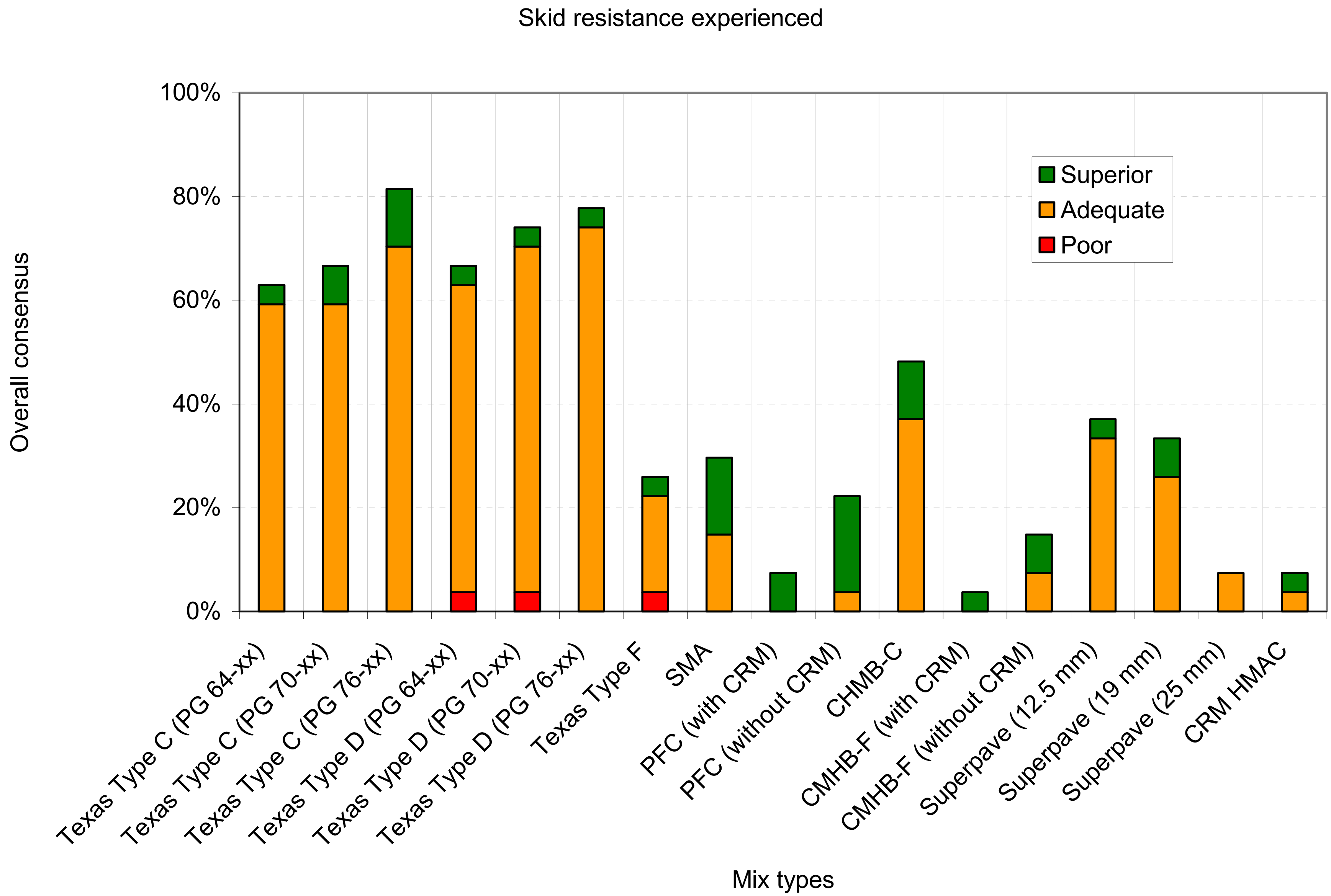

Figure 14. Skid Resistance Experienced

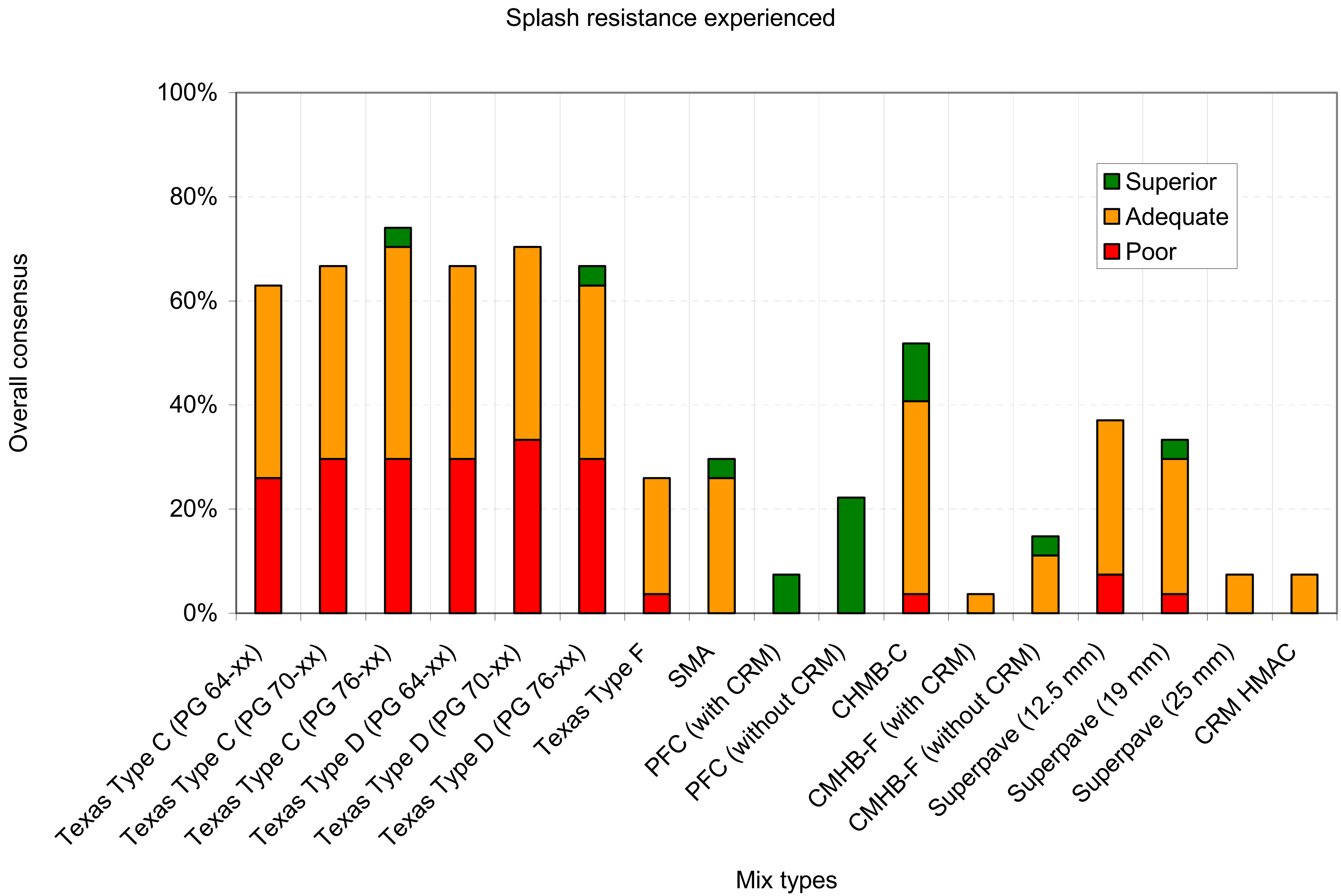

Figure 15. Splash Resistance Experienced

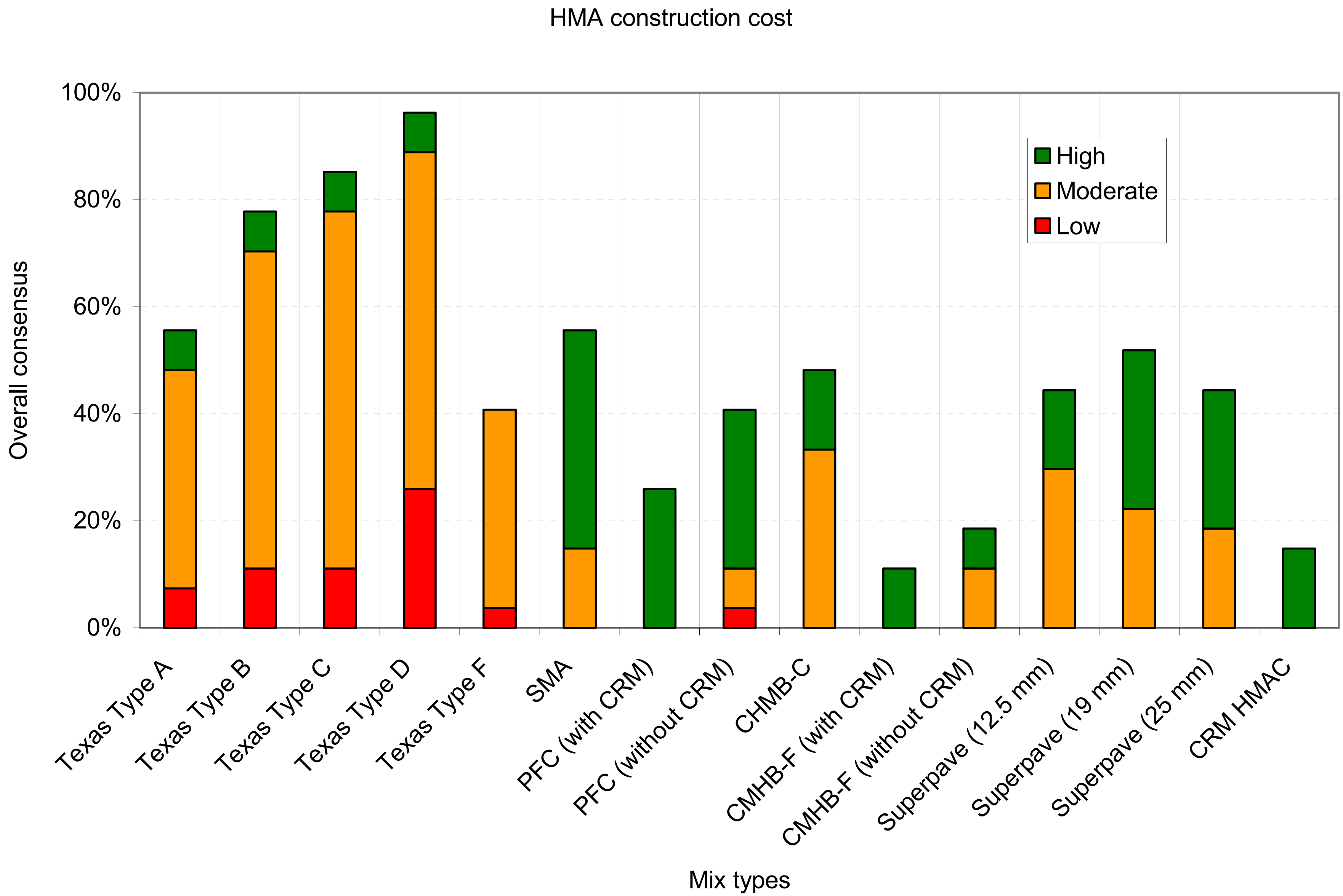

Figure 16. HMA Construction Cost

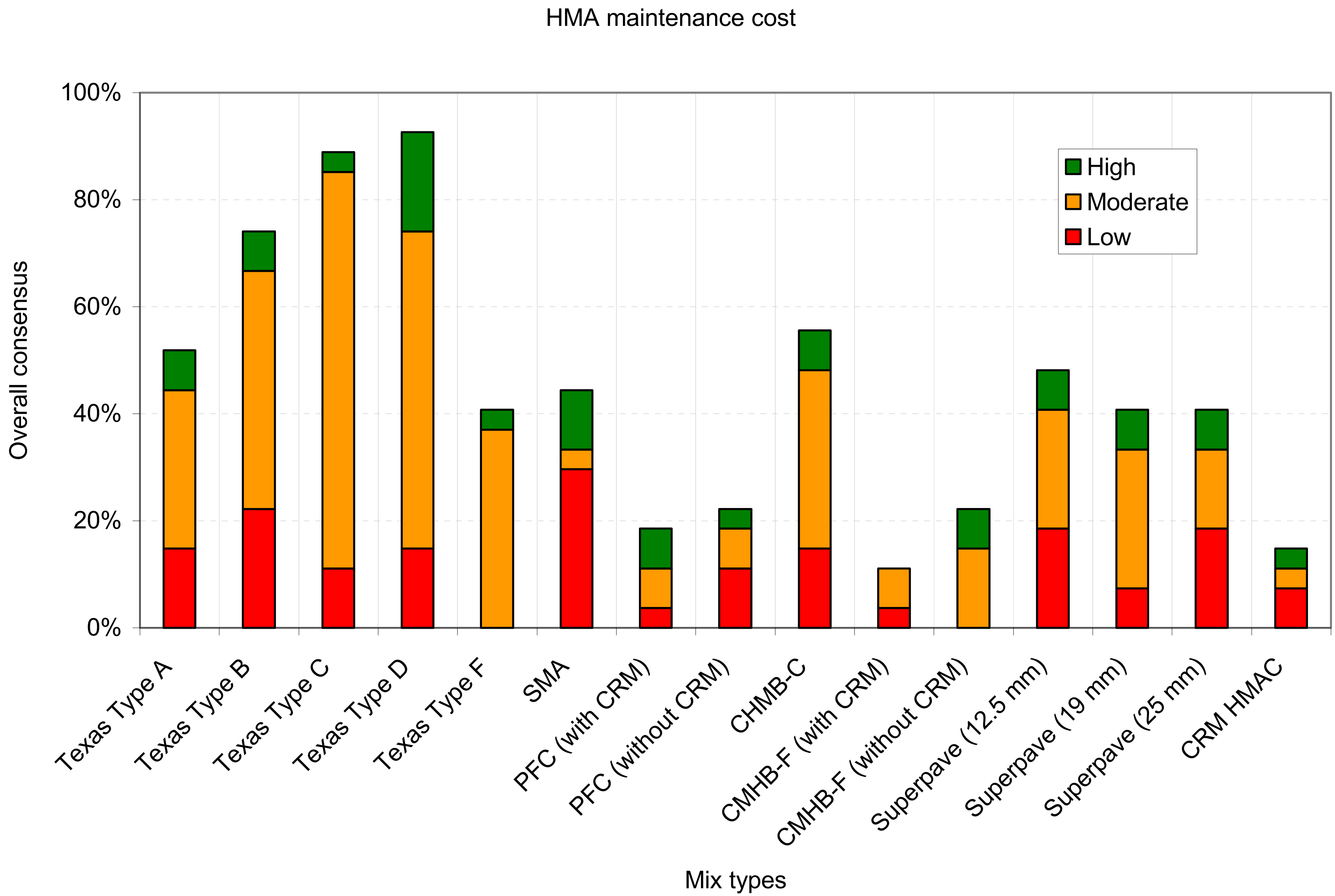

Figure 17. HMA Maintenance Cost

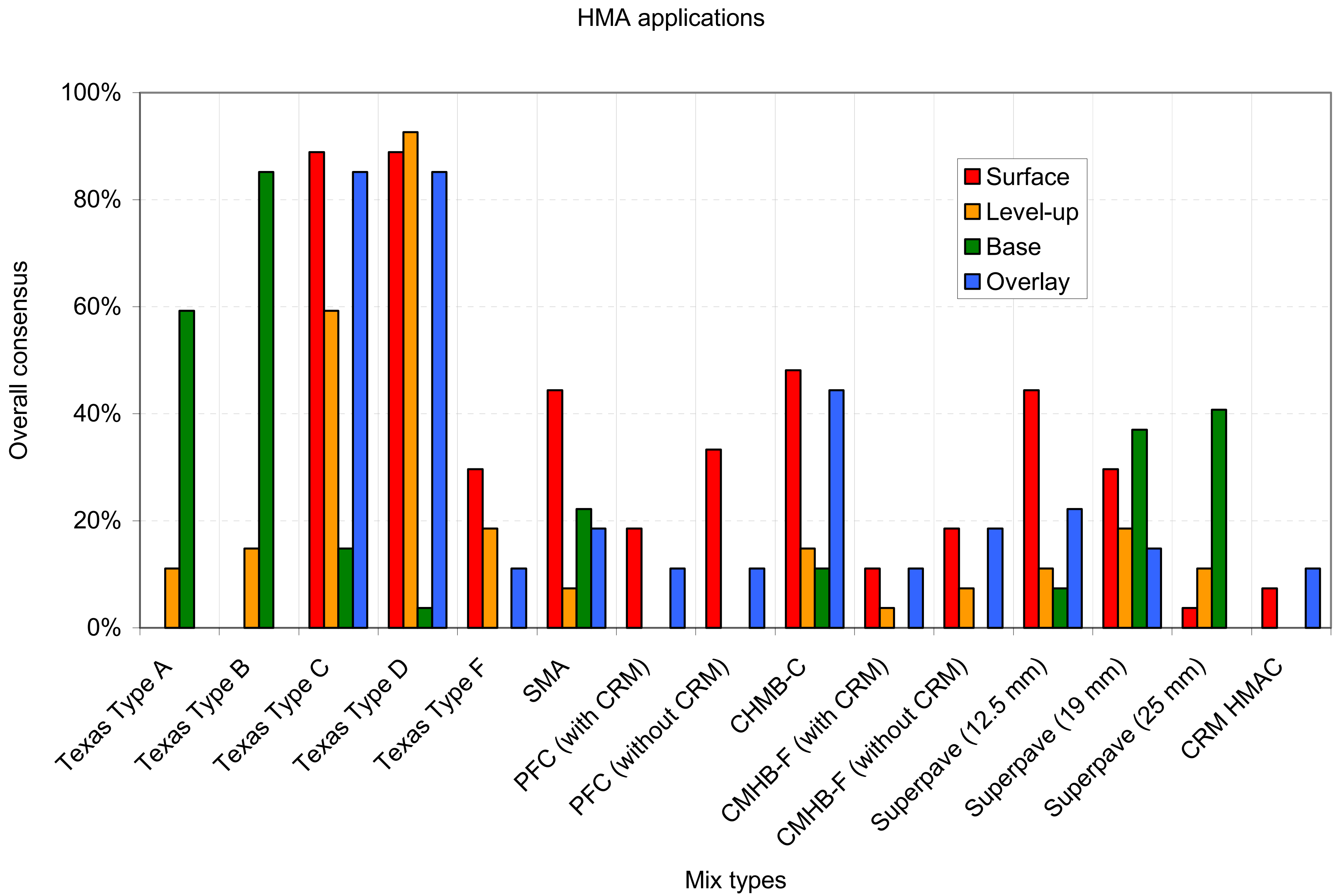

Figure 18. HMA Applications

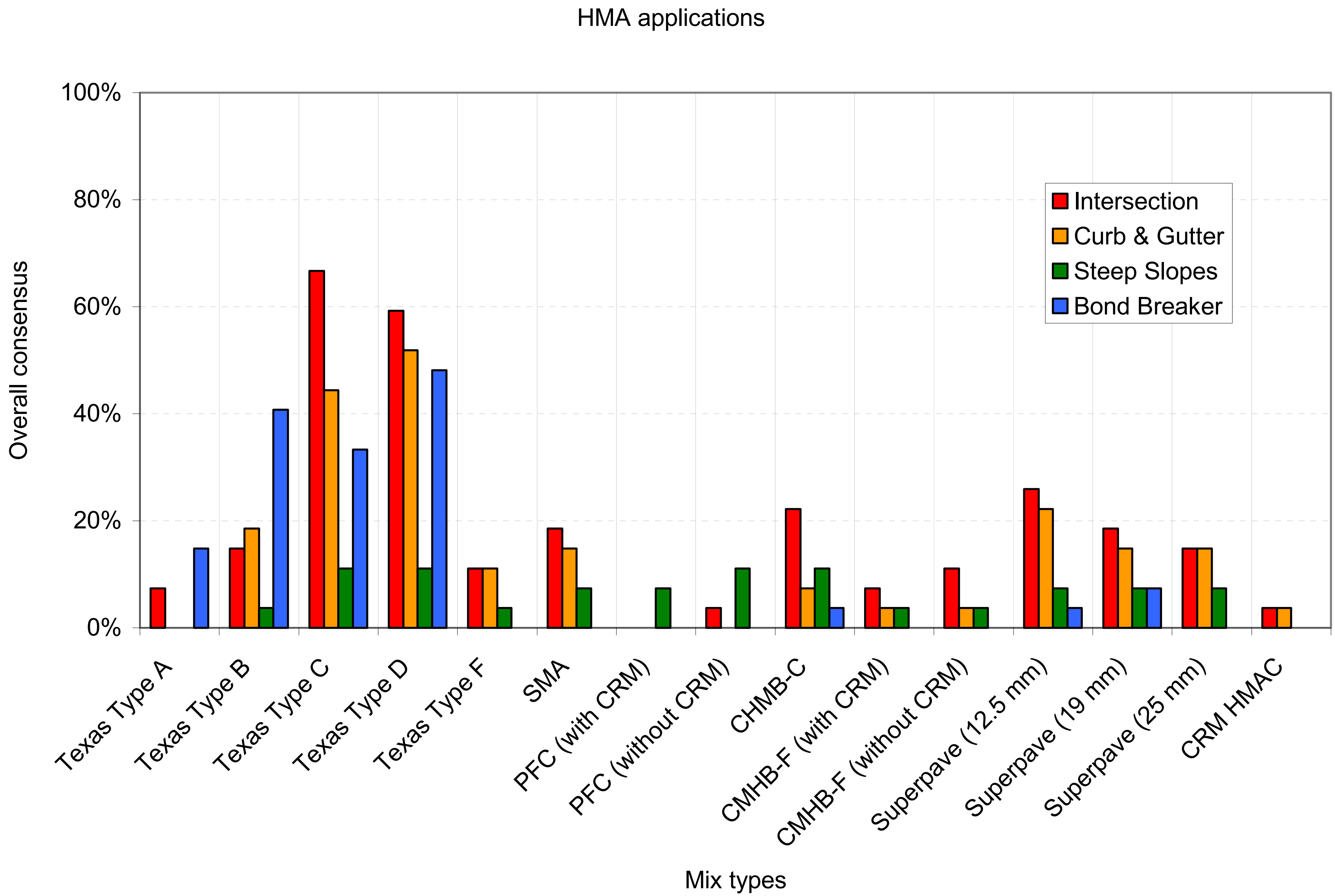

Figure 19. HMA Applications (Cont)

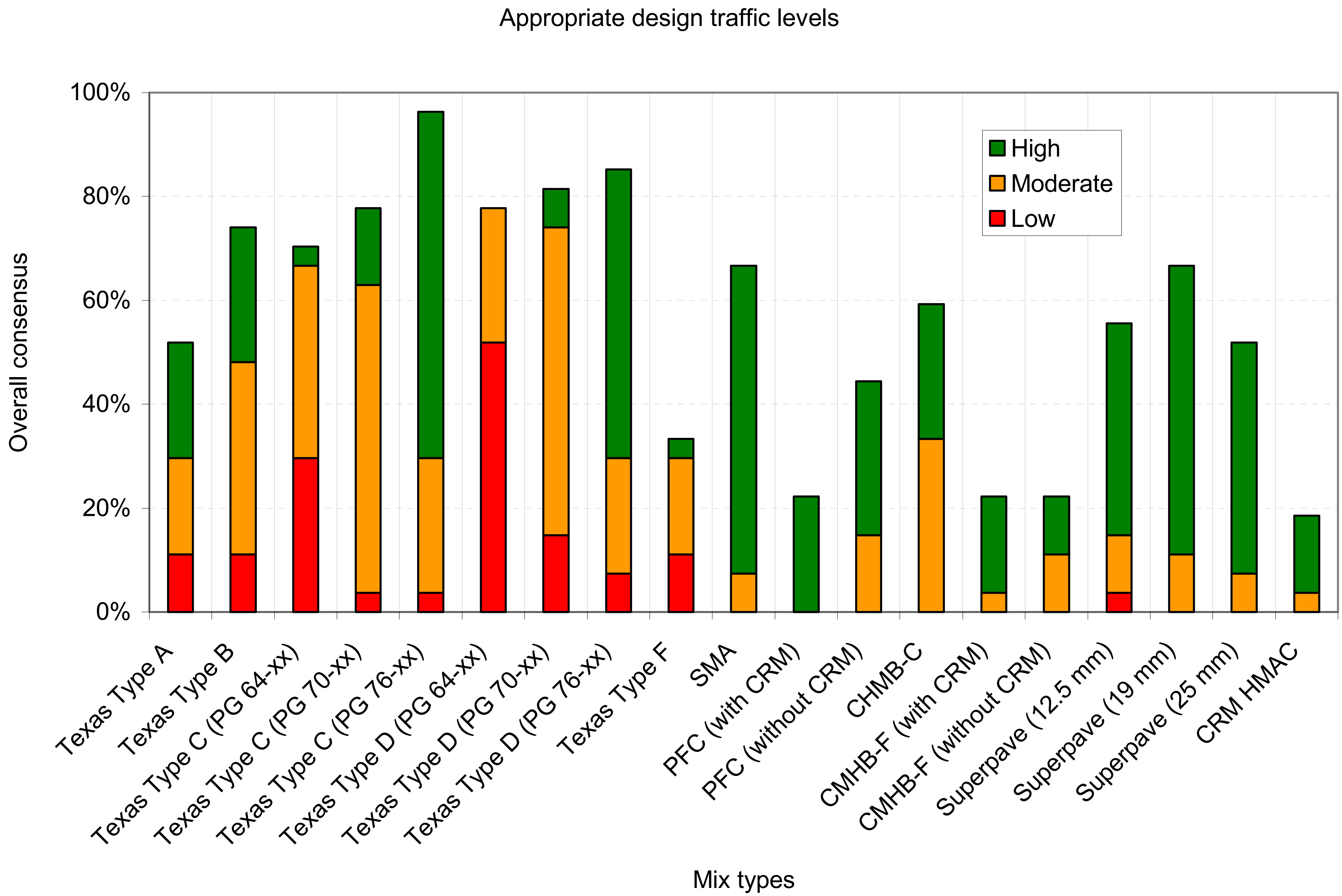

Figure 20. Appropriate design traffic levels

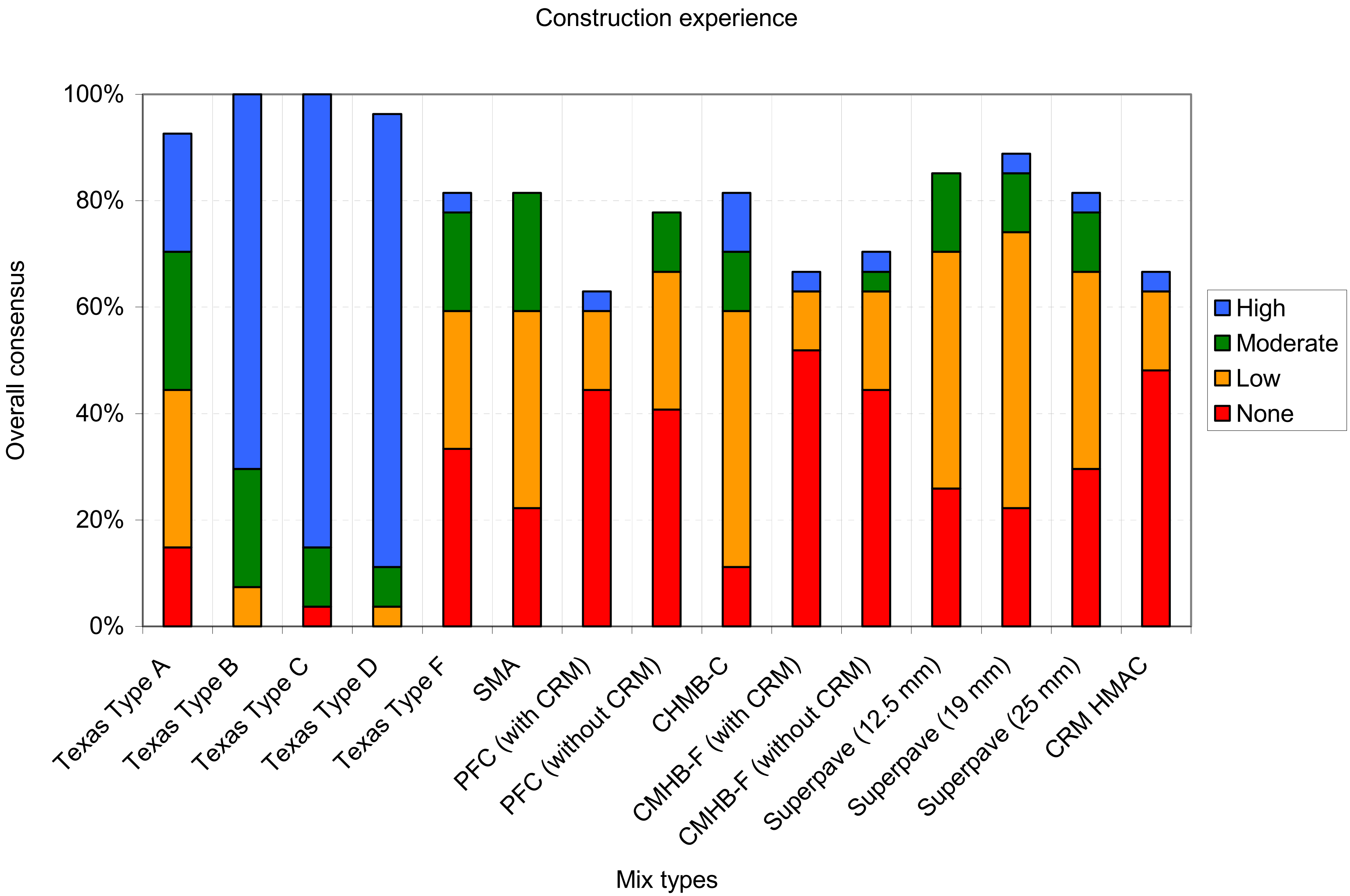

Figure 21. Construction Experience

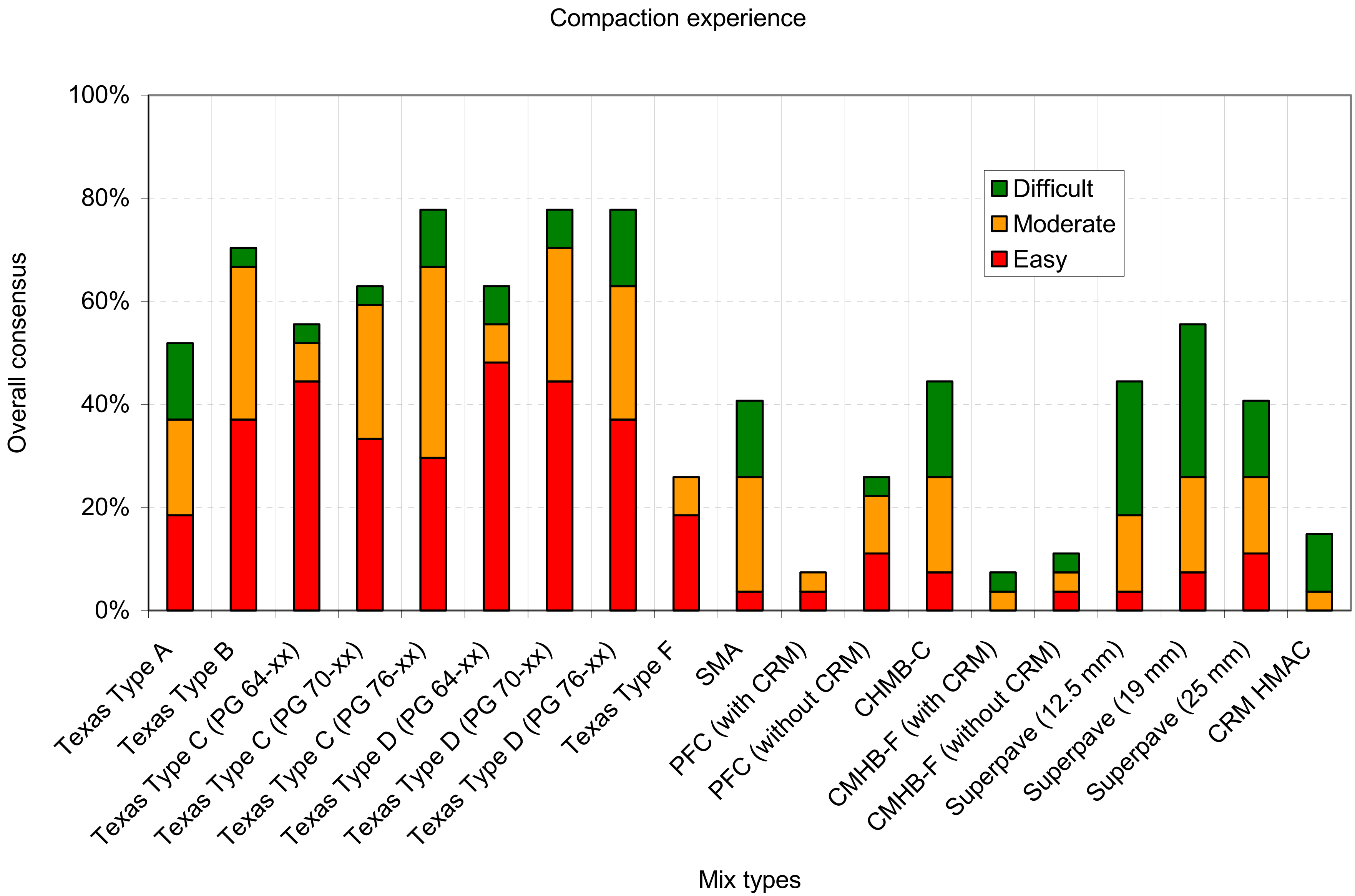

Figure 22. Compaction Experience

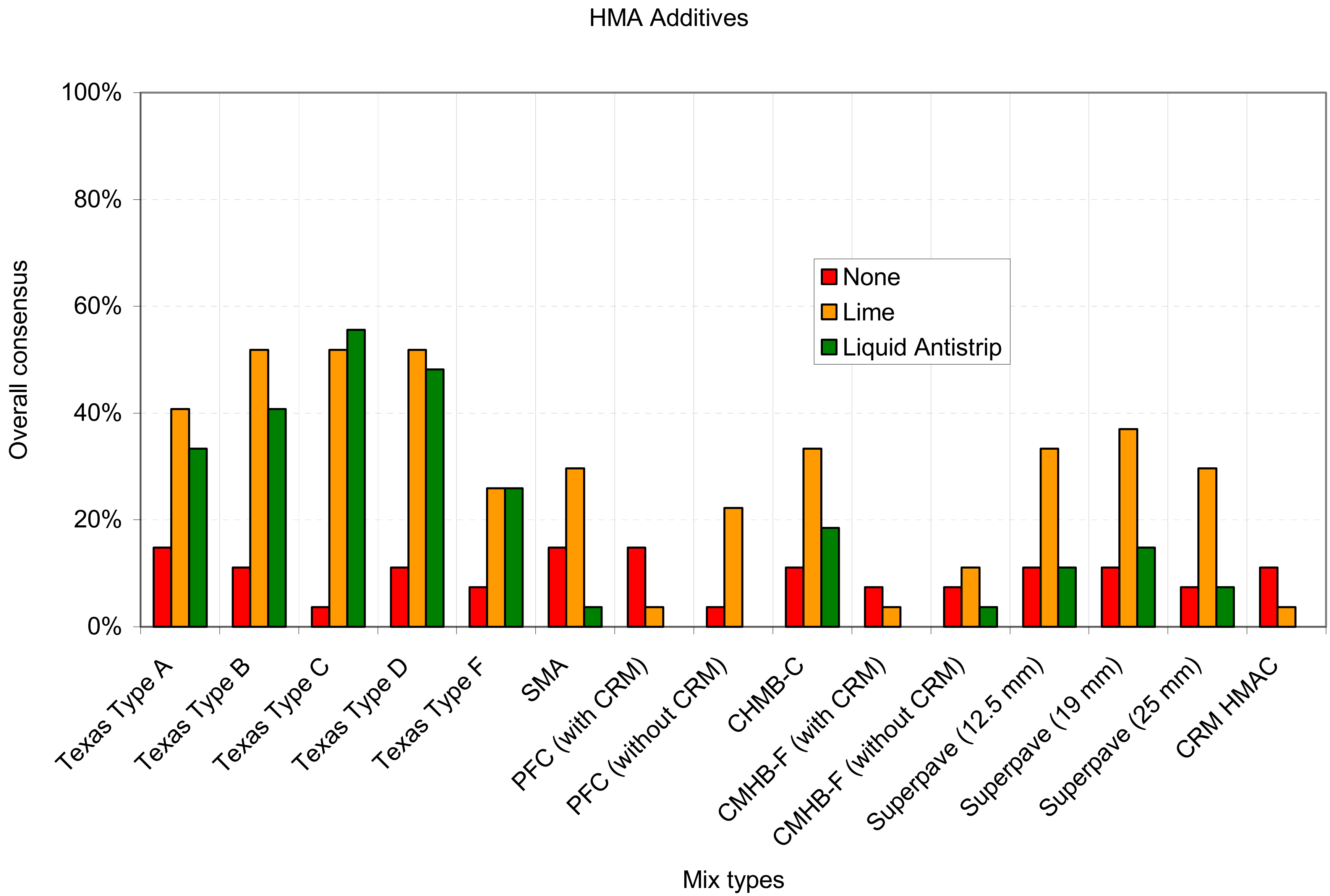

Figure 23. Additives used with HMA

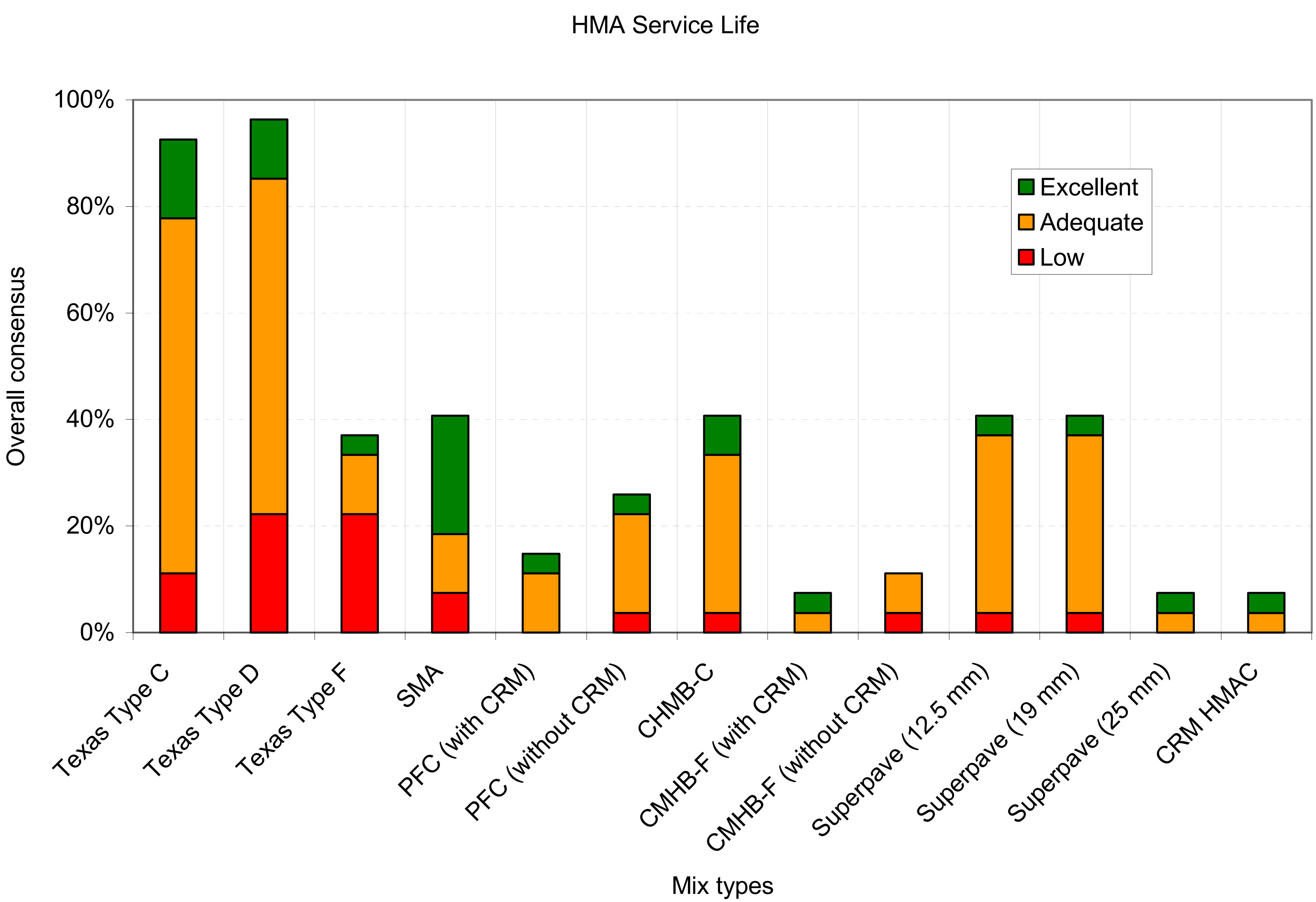

Figure 24. HMA Service Life

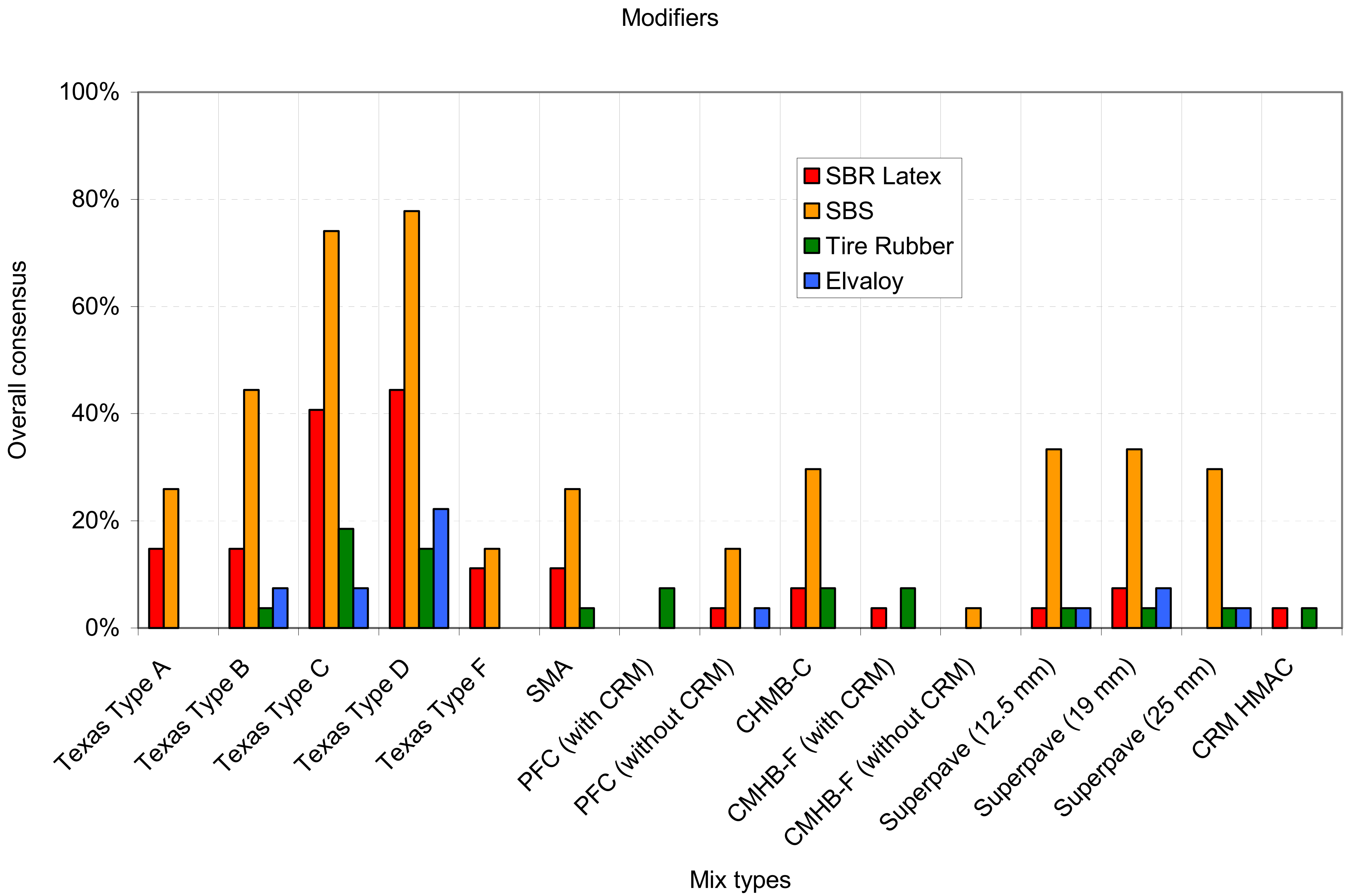

Figure 25. Modifiers used with HMA

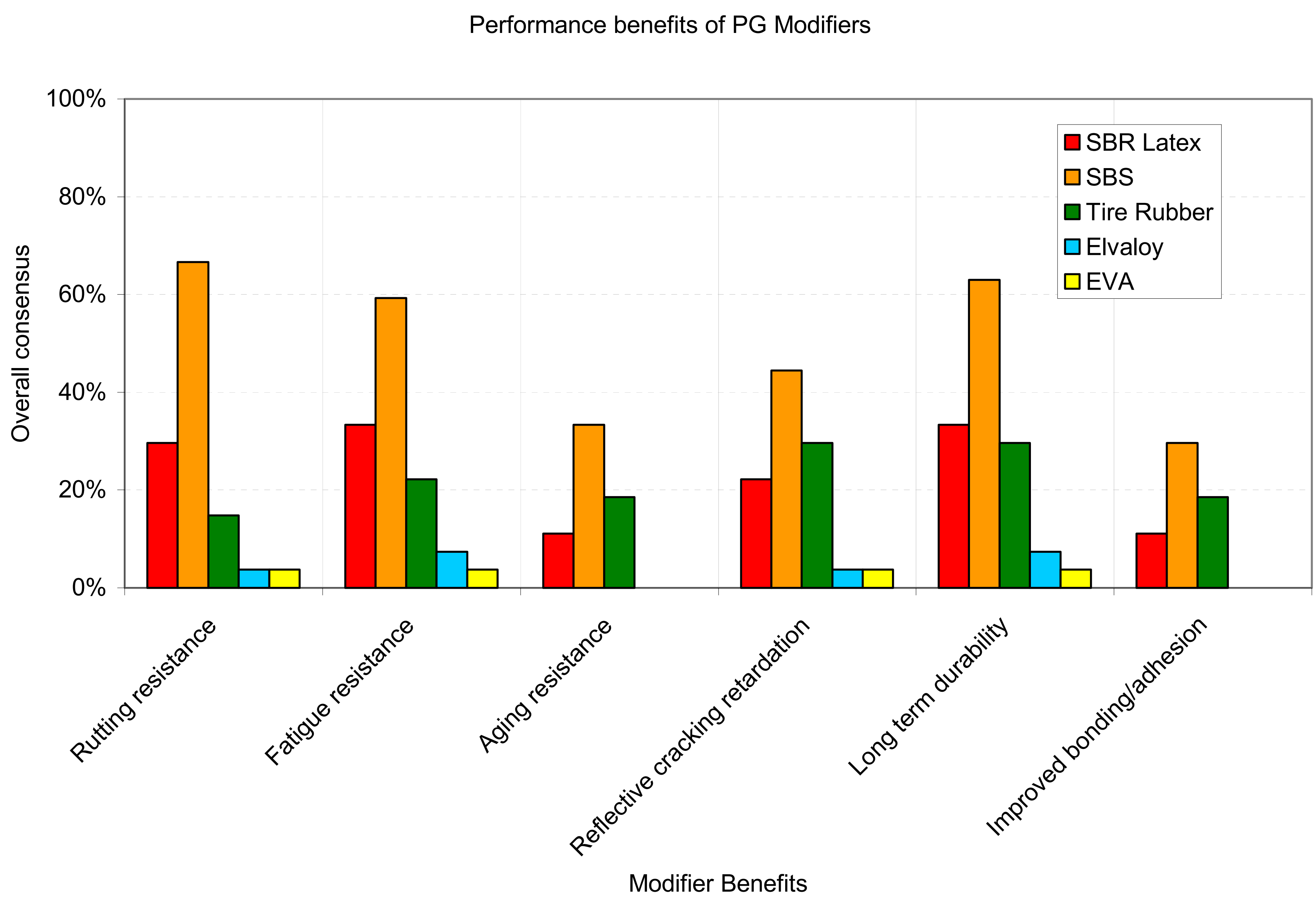

Figure 26. Performance Benefits of Modifiers

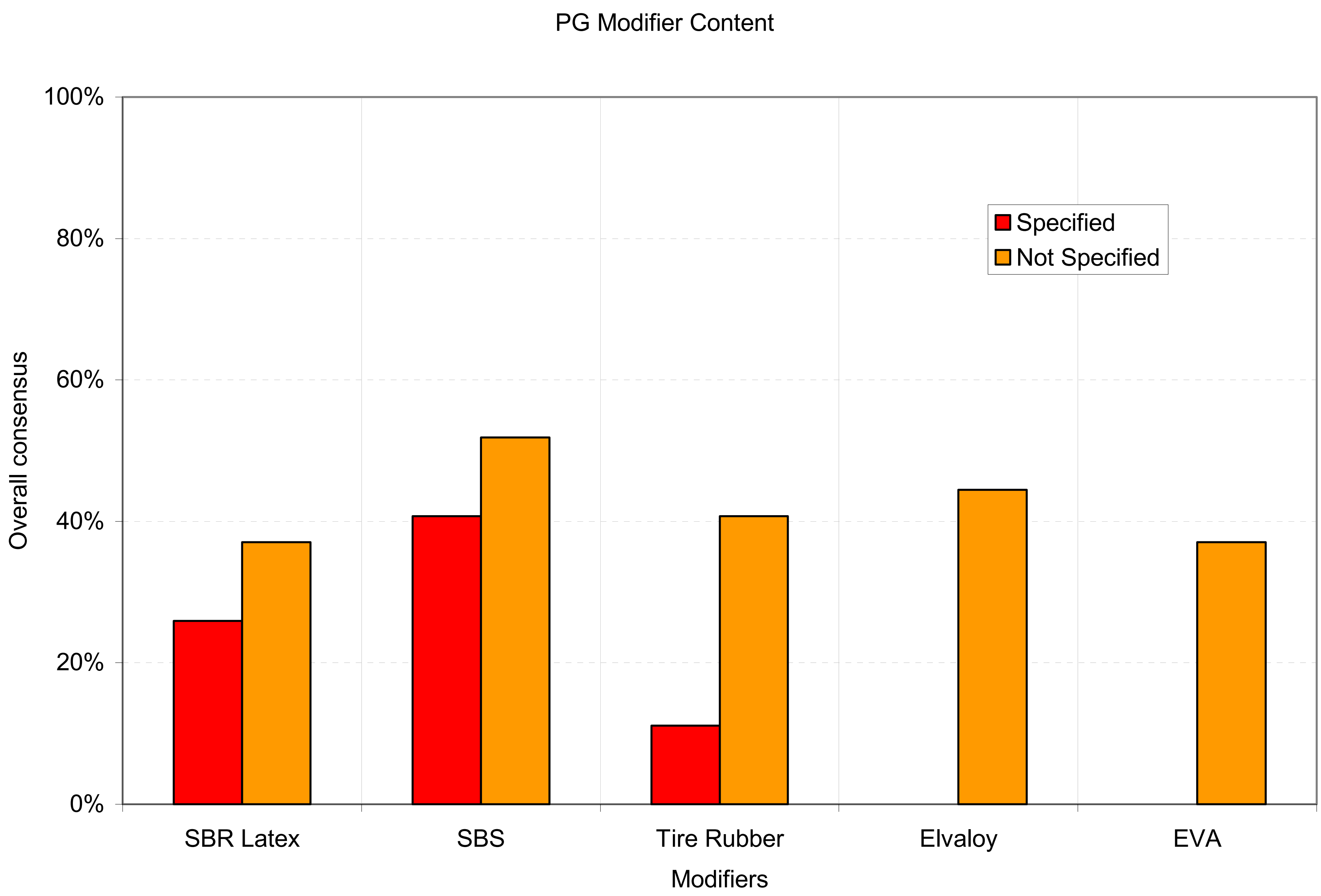

Figure 27. PG Modifier Content (Specified or Not Specified)

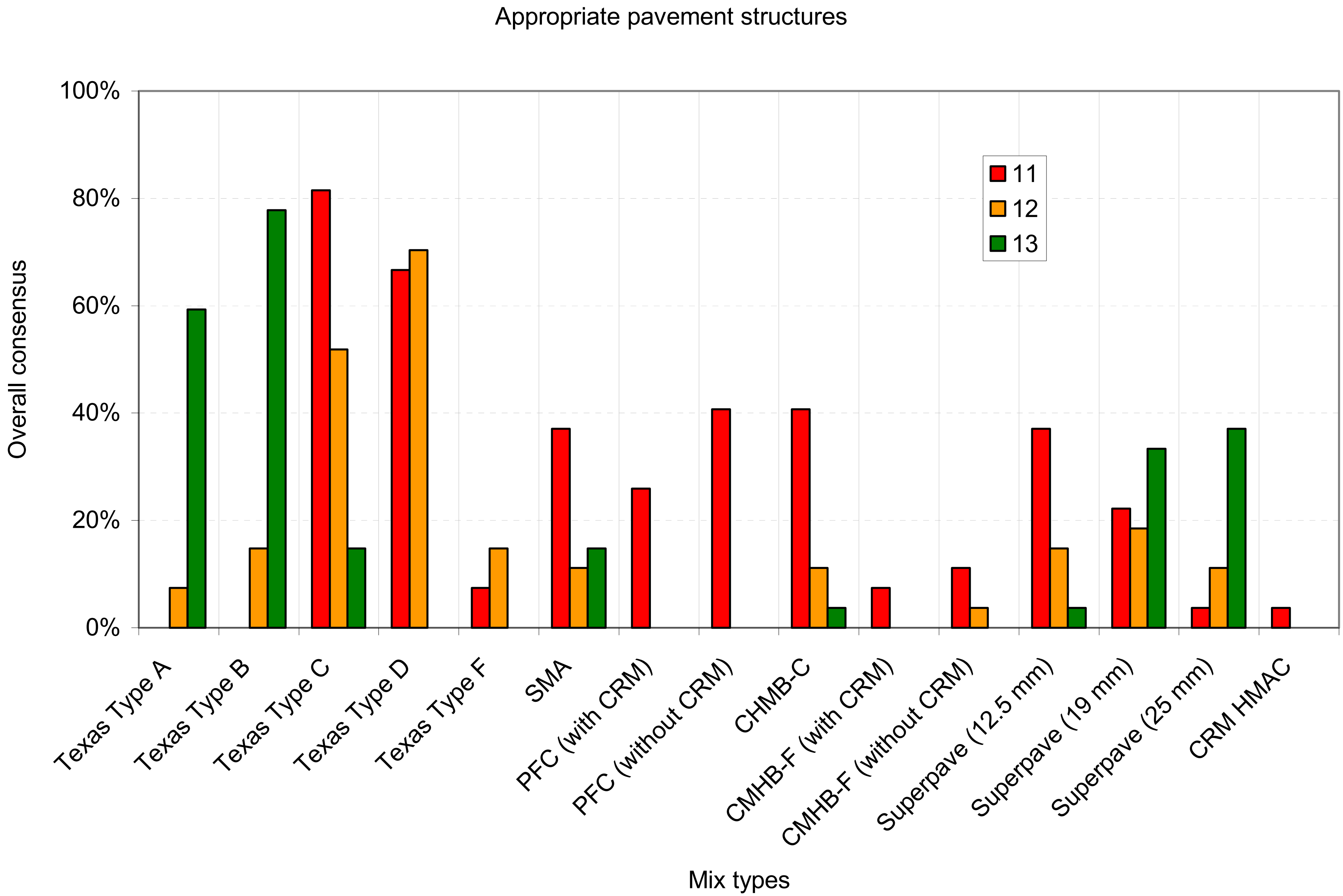

Figure 28. Appropriate Pavement Structures

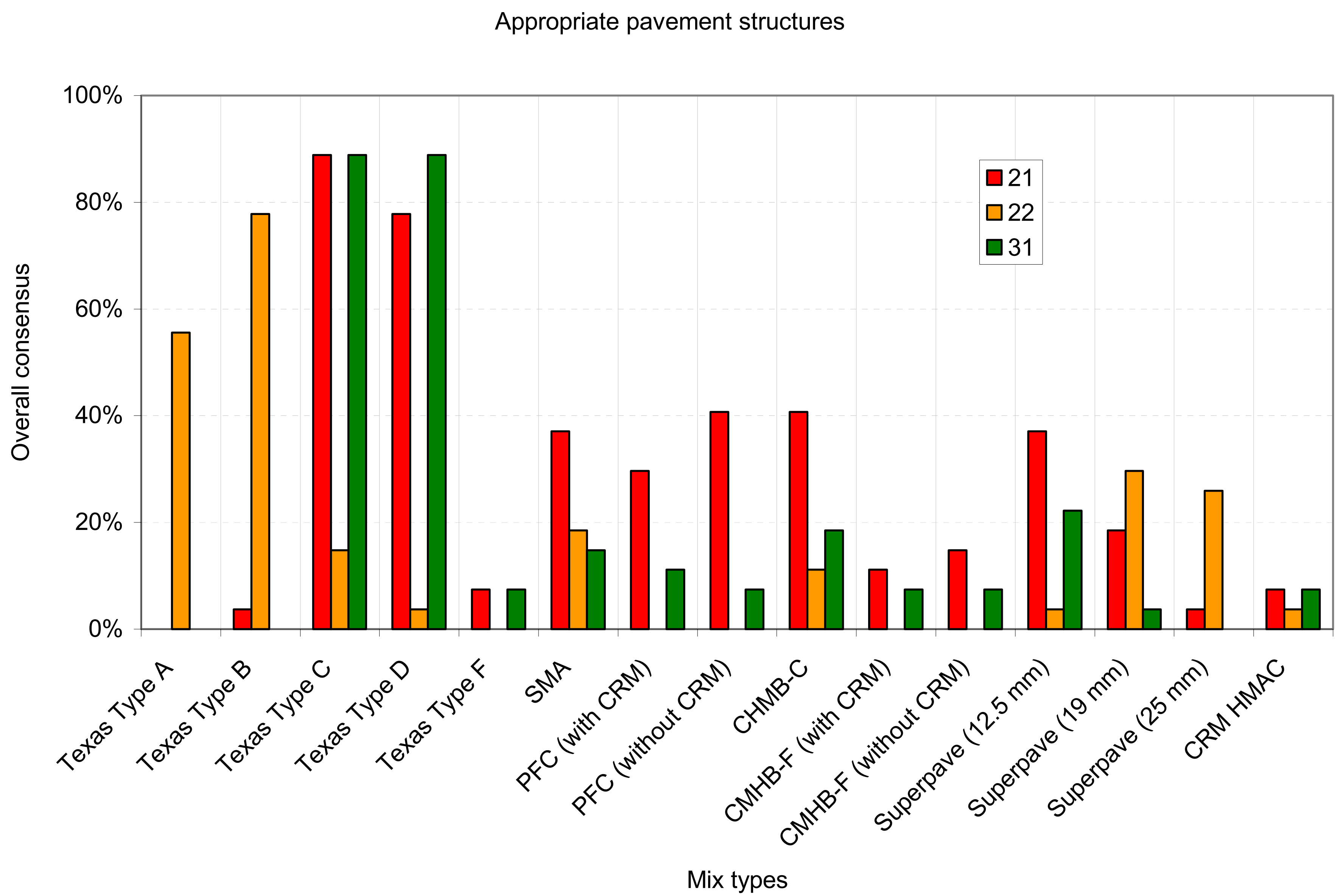

Figure 29. Appropriate Pavement Structures (Cont)

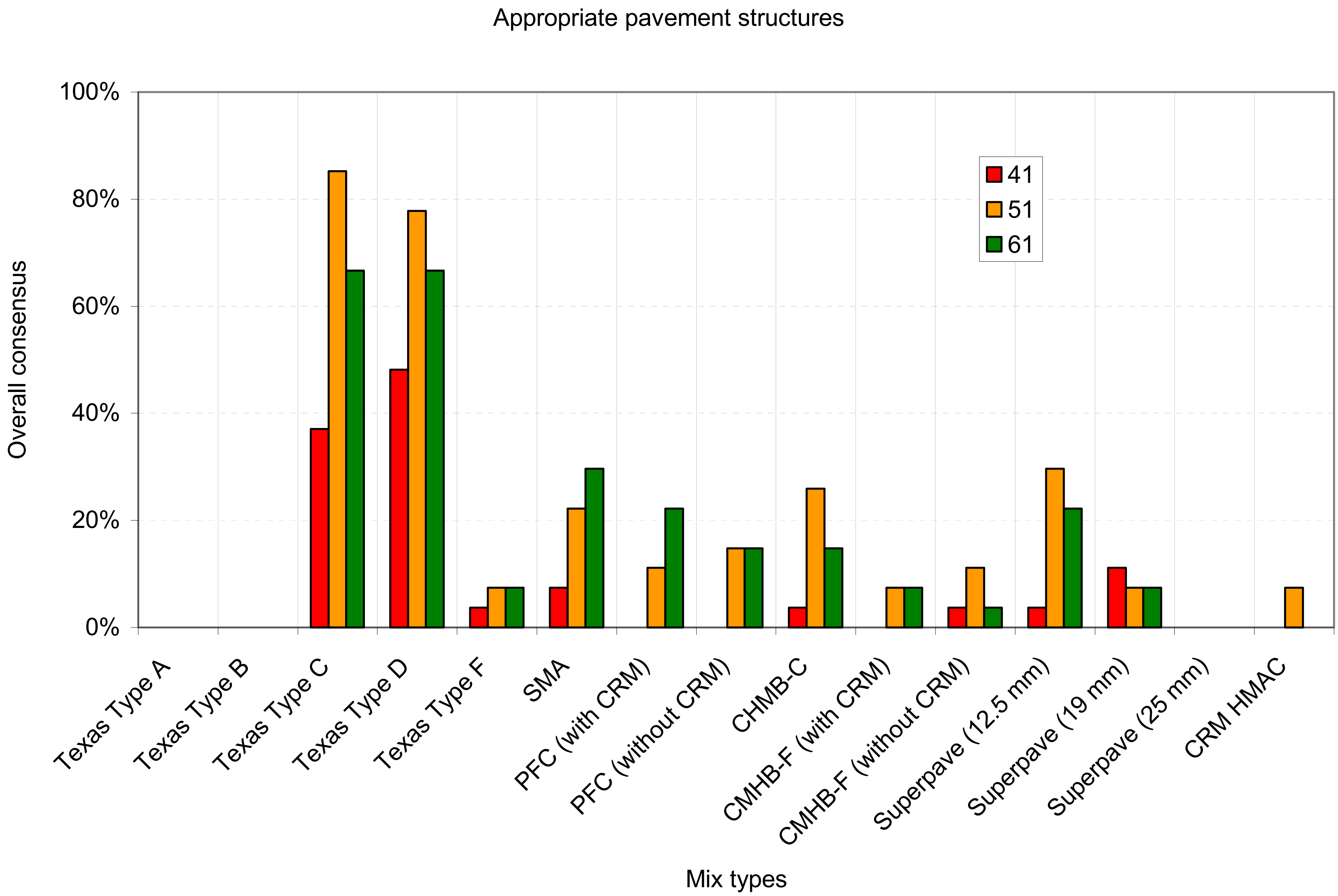

Figure 30. Appropriate Pavement Structures (Cont)

APPENDIX A

P4824 Survey: Guidelines for Selecting Asphalt Mixtures and Evaluation of Polymer-Modified Mixes

A1. Introduction

The purpose of this survey is (1) to gather information required for the selection of asphalt mixtures (HMA) and polymer modified binders (PMBs) to be used in TxDOT research study Project 0-4824 and (2) to identify and bring together current practices, opinions and applications towards the development of guidelines for the selection of HMA and PMBs in Texas.

TxDOT currently uses regular dense graded mixes such as type A, B, C, D and F, open graded mixes such as coarse matrix high binder (CMHB) and permeable friction course (PFC), stone matrix asphalt (SMA) and Superpave. Project 0-4824 will develop guidelines that will assist designers in the selection of asphalt mix types while considering factors such as application, traffic, environment, subsurface pavement structure, existing pavement condition and cost. The project will also address the use of PMBs. Several Texas districts require the use of polymer modified performance grade (PG) binders to address insufficient mixture resistance to distress or inadequate performance without guidelines. It is expected that at the end of this project guidelines will be available to TxDOT personnel on how to best address specific performance problems.

The time required to complete the survey is estimated to be between ***1 – 2 hours***. Note that the survey does not need to be completed in ***one sitting*** but can be saved and re-opened at a later stage. The document must be ***saved*** to retain the information input during a sitting. Each page of the survey asks a question and provides a number of responses. Users may respond to a question by clicking the corresponding box. Editable fields are shaded. Most questions will accept multiple selections with the exception of those that require a single exclusive selection. Space is provided to add comments pertaining to a question if you wish to share additional information or if the responses to questions as provided do not fully address your answer.

Please contact me if you have questions while completing the survey. Thank you for taking the time to complete this survey.

Survey Deadline: 5 January 2004

A2. Contact information

01. Name:

02. Address:

03. City:

04. District: Paris (Click on the field and select your district)

05. Telephone:

06. Fax:

07. E-mail: @dot.state.tx.us

08. What would be the best way to contact you if we have any questions:

☐ E-mail ☐ Phone ☐ Fax

A3. HMA information

Indicate which generic HMA mixes have been and/or are currently used in your district. PFC and CMHB-F mixes have been split to distinguish those with crumb rubber modifier (CRM) and those without. Superpave mixes have been split by nominal maximum aggregate size. CRM HMAC is hot mix asphalt with crumb rubber modifier.

01. Texas Type A	☐
02. Texas Type B	☐
03. Texas Type C	☐
04. Texas Type D	☐
05. Texas Type F	☐
06. SMA	☐
07. PFC (with CRM)	☐
08. PFC (without CRM)	☐
09. CHMB-C	☐
10. CMHB-F (with CRM)	☐
11. CMHB-F (without CRM)	☐
12. Superpave (12.5 mm)	☐
13. Superpave (19 mm)	☐
14. Superpave (25 mm)	☐
15. CRM HMAC	☐
16. Other*:	☐
17. Other*:	☐
18. Other*:	☐
19. Other*:	☐
20. Other*:	☐

* Please specify

NOTE: Fields 16 – 20 may be filled with HMA mixes not included in fields 01 – 15. Only hot-mix related information is sought – information pertaining to cold-mixes and surface seals will not be addressed as part of this survey.

Comments:

A4. HMA selection influence factors

Indicate the decision factors influencing your choice of asphalt mix.

01. District policy	☐
02. Past performance experience	☐
03. Engineering judgment	☐
04. TxDOT research	☐
05. Other research	☐
06. Experimentation	☐
07. Mechanistic design	☐
08. NAPA Guidelines	☐
09. Consultants	☐
10. Other*:	☐

* Please specify

NOTE: Multiple selections are acceptable. Field 10 may be filled with criteria not included. If necessary, additional criteria may be listed in the comments box.

Comments:

A5. Mix selection criteria

Indicate criteria used for mix selection and rank the importance of the criteria (when appropriate) as follows:

(1) Low importance (2) Important (3) Very important (Select only one)

Criteria	1	2	3
01. Traffic	☐	☐	☐
02. Temperature	☐	☐	☐
03. Rainfall	☐	☐	☐
04. Total cost	☐	☐	☐
05. Underlying pavement structure	☐	☐	☐
06. Road geometry	☐	☐	☐
07. Service life	☐	☐	☐
08. Layer thickness	☐	☐	☐
09. Materials adequacy	☐	☐	☐
10. Materials availability	☐	☐	☐
11. Existing pavement condition	☐	☐	☐
12. Safety (accidents)	☐	☐	☐
13. Other*:	☐	☐	☐
14. Other*:	☐	☐	☐
15. Other*:	☐	☐	☐

* Please specify

NOTE: Select only 1, 2 or 3 for each criterion. Fields 13 – 15 may be filled with criteria not included in the list. If necessary, additional criteria may be listed in the comments box.

Comments:

A6. HMA laboratory design

Indicate your general opinion of the laboratory mix design procedures for the listed mixes. This question is included because designers may, for example, not select a mixture based on their opinion of the complexity of the mix design procedure for a particular mix.

Mix	Poor	Adequate	Superior
01. Texas Type A	☐	☐	☐
02. Texas Type B	☐	☐	☐
03. Texas Type C	☐	☐	☐
04. Texas Type D	☐	☐	☐
05. Texas Type F	☐	☐	☐
06. SMA	☐	☐	☐
07. PFC (with CRM)	☐	☐	☐
08. PFC (without CRM)	☐	☐	☐
09. CHMB-C	☐	☐	☐
10. CMHB-F (with CRM)	☐	☐	☐
11. CMHB-F (without CRM)	☐	☐	☐
12. Superpave (12.5 mm)	☐	☐	☐
13. Superpave (19 mm)	☐	☐	☐
14. Superpave (25 mm)	☐	☐	☐
15. CRM HMAC	☐	☐	☐
16.	☐	☐	☐
17.	☐	☐	☐
18.	☐	☐	☐
19.	☐	☐	☐
20.	☐	☐	☐

NOTE: Select only one option for each mix type.

Comments:

A7. HMA performance expected

Indicate the relevant performance characteristics the listed mixes are *expected* to alleviate. Note this is not necessarily the performance enhancing characteristic experienced, which is addressed in a subsequent question. This question addresses the performance expectations of different asphalt mixes regardless of asphalt binder used. For simplicity, consider the performance of the mix ***without modified binders***.

Mix	Rutting	Cracking/ Fatigue	Noise	Skid	Splash	Drainage Problems
01. Texas Type A	☐	☐				☐
02. Texas Type B	☐	☐				☐
03. Texas Type C	☐	☐	☐	☐	☐	☐
04. Texas Type D	☐	☐	☐	☐	☐	☐
05. Texas Type F	☐	☐	☐	☐	☐	☐
06. SMA	☐	☐	☐	☐	☐	☐
07. PFC (with CRM)	☐	☐	☐	☐	☐	☐
08. PFC (without CRM)	☐	☐	☐	☐	☐	☐
09. CHMB-C	☐	☐	☐	☐	☐	☐
10. CMHB-F (with CRM)	☐	☐	☐	☐	☐	☐
11. CMHB-F (without CRM)	☐	☐	☐	☐	☐	☐
12. Superpave (12.5 mm)	☐	☐	☐	☐	☐	☐
13. Superpave (19 mm)	☐	☐	☐	☐	☐	☐
14. Superpave (25 mm)	☐	☐				☐
15. CRM HMAC	☐	☐	☐	☐	☐	☐
16.	☐	☐	☐	☐	☐	☐
17.	☐	☐	☐	☐	☐	☐
18.	☐	☐	☐	☐	☐	☐
19.	☐	☐	☐	☐	☐	☐
20.	☐	☐	☐	☐	☐	☐

NOTE: Multiple selections are allowed for each mix. If additional performance characteristics are expected, please note these in your comments. Some of the options have been left blank intentionally since these don't apply to mixes used for bases.

Comments:

A8. HMA problems experienced

Indicate mix related problems *experienced* regardless of asphalt binder grade. Clearly the performance of a mix will vary depending on the asphalt binder used, e.g. less rutting when stiffer binders are used. The purpose of the question, however, is to rank the performance characteristics of the asphalt mixes. For simplicity, consider asphalt mixes with unmodified PG grades typically used in your district.

Mix	Rutting	Fatigue cracking	Reflective cracking	Long. cracking	Flushing	Segre-gation	Raveling	Stripping
01. Texas Type A	☐	☐	☐	☐	☐	☐	☐	☐
02. Texas Type B	☐	☐	☐	☐	☐	☐	☐	☐
03. Texas Type C	☐	☐	☒	☐	☐	☐	☐	☐
04. Texas Type D	☐	☐	☐	☐	☐	☐	☐	☐
05. Texas Type F	☐	☐	☐	☐	☐	☐	☐	☐
06. SMA	☐	☐	☐	☐	☐	☐	☐	☐
07. PFC (with CRM)	☐	☐	☐	☐	☐	☐	☐	☐
08. PFC (without CRM)	☐	☐	☐	☐	☐	☐	☐	☐
09. CHMB-C	☐	☐	☐	☐	☐	☐	☐	☐
10. CMHB-F (with CRM)	☐	☐	☐	☐	☐	☐	☐	☐
11. CMHB-F (without CRM)	☐	☐	☐	☐	☐	☐	☐	☐
12. Superpave (12.5 mm)	☐	☐	☐	☐	☐	☐	☐	☐
13. Superpave (19 mm)	☐	☐	☐	☐	☐	☐	☐	☐
14. Superpave (25 mm)	☐	☐	☐	☐	☐	☐	☐	☐
15. CRM HMAC	☐	☐	☐	☐	☐	☐	☐	☐
16.	☐	☐	☐	☐	☐	☐	☐	☐
17.	☐	☐	☐	☐	☐	☐	☐	☐
18.	☐	☐	☐	☐	☐	☐	☐	☐
19.	☐	☐	☐	☐	☐	☐	☐	☐
20.	☐	☐	☐	☐	☐	☐	☐	☐

NOTE: Multiple selections are allowed for each mix. If additional problems were experienced, please note these in your comments.

Comments:

A9. Ranking of HMA performance experienced

Given question 8 above, indicate the relevant performance (in terms of resistance) of the listed mixes experienced, ranked as follows: (1) Poor (2) Adequate (3) Superior – select only one of these per mix and performance parameter.

	Structural performance				Functional performance		
	Rutting	Fatigue cracking	Reflective cracking	Longitud. cracking	Noise	Skid	Splash
Mix	1 2 3	1 2 3	1 2 3	1 2 3	1 2 3	1 2 3	1 2 3
01. Texas Type A	☐ ☐ ☐	☐ ☐ ☐	☐ ☐ ☐	☐ ☐ ☐			
02. Texas Type B	☐ ☐ ☐	☐ ☐ ☐	☐ ☐ ☐	☐ ☐ ☐			
03a. Texas Type C (PG 64-xx)	☐ ☐ ☐	☐ ☐ ☐	☐ ☐ ☐	☐ ☐ ☐	☐ ☐ ☐	☐ ☐ ☐	☐ ☐ ☐
03b. Texas Type C (PG 70-xx)	☐ ☐ ☐	☐ ☐ ☐	☐ ☐ ☐	☐ ☐ ☐	☐ ☐ ☐	☐ ☐ ☐	☐ ☐ ☐
03c. Texas Type C (PG 76-xx)	☐ ☐ ☐	☐ ☐ ☐	☐ ☐ ☐	☐ ☐ ☐	☐ ☐ ☐	☐ ☐ ☐	☐ ☐ ☐
04a. Texas Type D (PG 64-xx)	☐ ☐ ☐	☐ ☐ ☐	☐ ☐ ☐	☐ ☐ ☐	☐ ☐ ☐	☐ ☐ ☐	☐ ☐ ☐
04b. Texas Type D (PG 70-xx)	☐ ☐ ☐	☐ ☐ ☐	☐ ☐ ☐	☐ ☐ ☐	☐ ☐ ☐	☐ ☐ ☐	☐ ☐ ☐
04c. Texas Type D (PG 76-xx)	☐ ☐ ☐	☐ ☐ ☐	☐ ☐ ☐	☐ ☐ ☐	☐ ☐ ☐	☐ ☐ ☐	☐ ☐ ☐
05. Texas Type F	☐ ☐ ☐	☐ ☐ ☐	☐ ☐ ☐	☐ ☐ ☐	☐ ☐ ☐	☐ ☐ ☐	☐ ☐ ☐
06. SMA	☐ ☐ ☐	☐ ☐ ☐	☐ ☐ ☐	☐ ☐ ☐	☐ ☐ ☐	☐ ☐ ☐	☐ ☐ ☐
07. PFC (with CRM)	☐ ☐ ☐	☐ ☐ ☐	☐ ☐ ☐	☐ ☐ ☐	☐ ☐ ☐	☐ ☐ ☐	☐ ☐ ☐
08. PFC (without CRM)	☐ ☐ ☐	☐ ☐ ☐	☐ ☐ ☐	☐ ☐ ☐	☐ ☐ ☐	☐ ☐ ☐	☐ ☐ ☐
09. CHMB-C	☐ ☐ ☐	☐ ☐ ☐	☐ ☐ ☐	☐ ☐ ☐	☐ ☐ ☐	☐ ☐ ☐	☐ ☐ ☐
10. CMHB-F (with CRM)	☐ ☐ ☐	☐ ☐ ☐	☐ ☐ ☐	☐ ☐ ☐	☐ ☐ ☐	☐ ☐ ☐	☐ ☐ ☐
11. CMHB-F (without CRM)	☐ ☐ ☐	☐ ☐ ☐	☐ ☐ ☐	☐ ☐ ☐	☐ ☐ ☐	☐ ☐ ☐	☐ ☐ ☐
12. Superpave (12.5 mm)	☐ ☐ ☐	☐ ☐ ☐	☐ ☐ ☐	☐ ☐ ☐	☐ ☐ ☐	☐ ☐ ☐	☐ ☐ ☐
13. Superpave (19 mm)	☐ ☐ ☐	☐ ☐ ☐	☐ ☐ ☐	☐ ☐ ☐	☐ ☐ ☐	☐ ☐ ☐	☐ ☐ ☐
14. Superpave (25 mm)	☐ ☐ ☐	☐ ☐ ☐	☐ ☐ ☐	☐ ☐ ☐			
15. CRM HMAC	☐ ☐ ☐	☐ ☐ ☐	☐ ☐ ☐	☐ ☐ ☐	☐ ☐ ☐	☐ ☐ ☐	☐ ☐ ☐
16.	☐ ☐ ☐	☐ ☐ ☐	☐ ☐ ☐	☐ ☐ ☐	☐ ☐ ☐	☐ ☐ ☐	☐ ☐ ☐
17.	☐ ☐ ☐	☐ ☐ ☐	☐ ☐ ☐	☐ ☐ ☐	☐ ☐ ☐	☐ ☐ ☐	☐ ☐ ☐
18.	☐ ☐ ☐	☐ ☐ ☐	☐ ☐ ☐	☐ ☐ ☐	☐ ☐ ☐	☐ ☐ ☐	☐ ☐ ☐
19.	☐ ☐ ☐	☐ ☐ ☐	☐ ☐ ☐	☐ ☐ ☐	☐ ☐ ☐	☐ ☐ ☐	☐ ☐ ☐
20.	☐ ☐ ☐	☐ ☐ ☐	☐ ☐ ☐	☐ ☐ ☐	☐ ☐ ☐	☐ ☐ ☐	☐ ☐ ☐

NOTE: Texas Type C and D mixes have been split by PG grade binders used with the mix. For the other mixes, rank these in terms of the PG grade binder typically used with these mixes in your district.

Comments:

A10. HMA construction cost

Indicate your opinion of relative unmodified mix construction cost in general (construction cost will depend on the lift thickness associated with each mix type as well as material requirements). If particular mixes in your district/area are typically produced with modified binders then relate the costs of these to unmodified mixes used in your district. Costs may be related relative to the cost of Type D mixes with a PG 64-22 binder.

Mix	Low	Moderate	High
01. Texas Type A	☐	☐	☐
02. Texas Type B	☐	☐	☐
03. Texas Type C	☐	☐	☐
04. Texas Type D	☐	☐	☐
05. Texas Type F	☐	☐	☐
06. SMA	☐	☐	☐
07. PFC (with CRM)	☐	☐	☐
08. PFC (without CRM)	☐	☐	☐
09. CHMB-C	☐	☐	☐
10. CMHB-F (with CRM)	☐	☐	☐
11. CMHB-F (without CRM)	☐	☐	☐
12. Superpave (12.5 mm)	☐	☐	☐
13. Superpave (19 mm)	☐	☐	☐
14. Superpave (25 mm)	☐	☐	☐
15. CRM HMAC	☐	☐	☐
16.	☐	☐	☐
17.	☐	☐	☐
18.	☐	☐	☐
19.	☐	☐	☐
20.	☐	☐	☐

NOTE: Select only one option for each mix type.

Comments:

A11. HMA maintenance cost

Indicate your opinion of relative mix maintenance cost, again relative to the cost of maintaining a Type D mix, say. Maintenance costs include costs incurred for repairing, patching, crack filling, etc.

Mix	Low	Moderate	High
01. Texas Type A	☐	☐	☐
02. Texas Type B	☐	☐	☐
03. Texas Type C	☐	☐	☐
04. Texas Type D	☐	☐	☐
05. Texas Type F	☐	☐	☐
06. SMA	☐	☐	☐
07. PFC (with CRM)	☐	☐	☐
08. PFC (without CRM)	☐	☐	☐
09. CHMB-C	☐	☐	☐
10. CMHB-F (with CRM)	☐	☐	☐
11. CMHB-F (without CRM)	☐	☐	☐
12. Superpave (12.5 mm)	☐	☐	☐
13. Superpave (19 mm)	☐	☐	☐
14. Superpave (25 mm)	☐	☐	☐
15. CRM HMAC	☐	☐	☐
16.	☐	☐	☐
17.	☐	☐	☐
18.	☐	☐	☐
19.	☐	☐	☐
20.	☐	☐	☐

NOTE: Select only one option for each mix type.
Comments:

A12. Mix applications

Indicate typical mix applications.

Mix	Surface	Level-up	Base	Overlay	Inter-section	Curb & Gutter	Steep slopes	Bond breaker
01. Texas Type A	☐	☐	☐	☐	☐	☐	☐	☐
02. Texas Type B	☐	☐	☐	☐	☐	☐	☐	☐
03. Texas Type C	☐	☐	☐	☐	☐	☐	☐	☐
04. Texas Type D	☐	☐	☐	☐	☐	☐	☐	☐
05. Texas Type F	☐	☐	☐	☐	☐	☐	☐	☐
06. SMA	☐	☐	☐	☐	☐	☐	☐	☐
07. PFC (with CRM)	☐	☐	☐	☐	☐	☐	☐	☐
08. PFC (without CRM)	☐	☐	☐	☐	☐	☐	☐	☐
09. CHMB-C	☐	☐	☐	☐	☐	☐	☐	☐
10. CMHB-F (with CRM)	☐	☐	☐	☐	☐	☐	☐	☐
11. CMHB-F (without CRM)	☐	☐	☐	☐	☐	☐	☐	☐
12. Superpave (12.5 mm)	☐	☐	☐	☐	☐	☐	☐	☐
13. Superpave (19 mm)	☐	☐	☐	☐	☐	☐	☐	☐
14. Superpave (25 mm)	☐	☐	☐	☐	☐	☐	☐	☐
15. CRM HMAC	☐	☐	☐	☐	☐	☐	☐	☐
16.	☐	☐	☐	☐	☐	☐	☐	☐
17.	☐	☐	☐	☐	☐	☐	☐	☐
18.	☐	☐	☐	☐	☐	☐	☐	☐
19.	☐	☐	☐	☐	☐	☐	☐	☐
20.	☐	☐	☐	☐	☐	☐	☐	☐

NOTE: Multiple selections per mix are allowed. Add additional applications in your comments
Comments:

A13. Traffic considerations

Indicate traffic considerations for mix selection, in other words, select appropriate design traffic levels for the listed mixes, where:

Low	=	< 1 million design ESALS
Moderate	=	1 – 10 million design ESALS
High	=	> 10 million Design ESALS

Mix	Low	Moderate	High
01. Texas Type A	☐	☐	☐
02. Texas Type B	☐	☐	☐
03a. Texas Type C (PG 64-xx)	☐	☐	☐
03b. Texas Type C (PG 70-xx)	☐	☐	☐
03c. Texas Type C (PG 76-xx)	☐	☐	☐
04a. Texas Type D (PG 64-xx)	☐	☐	☐
04b. Texas Type D (PG 70-xx)	☐	☐	☐
04c. Texas Type D (PG 76-xx)	☐	☐	☐
05. Texas Type F	☐	☐	☐
06. SMA	☐	☐	☐
07. PFC (with CRM)	☐	☐	☐
08. PFC (without CRM)	☐	☐	☐
09. CHMB-C	☐	☐	☐
10. CMHB-F (with CRM)	☐	☐	☐
11. CMHB-F (without CRM)	☐	☐	☐
12. Superpave (12.5 mm)	☐	☐	☐
13. Superpave (19 mm)	☐	☐	☐
14. Superpave (25 mm)	☐	☐	☐
15. CRM HMAC	☐	☐	☐
16.	☐	☐	☐
17.	☐	☐	☐
18.	☐	☐	☐
19.	☐	☐	☐
20.	☐	☐	☐

NOTE: Texas Type C and D mixes have been split by PG grade binders used with the mix. Select only one option for each mix type.
Comments:

A14. Construction experience

Indicate districts (contractors included) experience with construction of the listed mixes.

Mix	None	Low	Moderate	High
01. Texas Type A	☐	☐	☐	☐
02. Texas Type B	☐	☐	☐	☐
03. Texas Type C	☐	☐	☐	☐
04. Texas Type D	☐	☐	☐	☐
05. Texas Type F	☐	☐	☐	☐
06. SMA	☐	☐	☐	☐
07. PFC (with CRM)	☐	☐	☐	☐
08. PFC (without CRM)	☐	☐	☐	☐
09. CHMB-C	☐	☐	☐	☐
10. CMHB-F (with CRM)	☐	☐	☐	☐
11. CMHB-F (without CRM)	☐	☐	☐	☐
12. Superpave (12.5 mm)	☐	☐	☐	☐
13. Superpave (19 mm)	☐	☐	☐	☐
14. Superpave (25 mm)	☐	☐	☐	☐
15. CRM HMAC	☐	☐	☐	☐
16.	☐	☐	☐	☐
17.	☐	☐	☐	☐
18.	☐	☐	☐	☐
19.	☐	☐	☐	☐
20.	☐	☐	☐	☐

NOTE: Select only one option for each mix type.
Comments:

A15. Compaction experience

Indicate your general experience with compaction of the listed mixes in the field i.e. how easy it is to obtain desired densities.

Mix	Easy	Moderate	Difficult
01. Texas Type A	☐	☐	☐
02. Texas Type B	☐	☐	☐
03a. Texas Type C (PG 64-xx)	☐	☐	☐
03b. Texas Type C (PG 70-xx)	☐	☐	☐
03c. Texas Type C (PG 76-xx)	☐	☐	☐
04a. Texas Type D (PG 64-xx)	☐	☐	☐
04b. Texas Type D (PG 70-xx)	☐	☐	☐
04c. Texas Type D (PG 76-xx)	☐	☐	☐
05. Texas Type F	☐	☐	☐
06. SMA	☐	☐	☐
07. PFC (with CRM)	☐	☐	☐
08. PFC (without CRM)	☐	☐	☐
09. CHMB-C	☐	☐	☐
10. CMHB-F (with CRM)	☐	☐	☐
11. CMHB-F (without CRM)	☐	☐	☐
12. Superpave (12.5 mm)	☐	☐	☐
13. Superpave (19 mm)	☐	☐	☐
14. Superpave (25 mm)	☐	☐	☐
15. CRM HMAC	☐	☐	☐
16.	☐	☐	☐
17.	☐	☐	☐
18.	☐	☐	☐
19.	☐	☐	☐
20.	☐	☐	☐

NOTE: Texas Type C and D mixes have been split by PG grade binders used with the mix. Select only one option for each mix type.

Comments:

A16. Additives

Indicate additives used/considered for the listed mixes.

Mix	None	Lime	Liquid antistrip
01. Texas Type A	☐	☐	☐
02. Texas Type B	☐	☐	☐
03. Texas Type C	☐	☐	☐
04. Texas Type D	☐	☐	☐
05. Texas Type F	☐	☐	☐
06. SMA	☐	☐	☐
07. PFC (with CRM)	☐	☐	☐
08. PFC (without CRM)	☐	☐	☐
09. CHMB-C	☐	☐	☐
10. CMHB-F (with CRM)	☐	☐	☐
11. CMHB-F (without CRM)	☐	☐	☐
12. Superpave (12.5 mm)	☐	☐	☐
13. Superpave (19 mm)	☐	☐	☐
14. Superpave (25 mm)	☐	☐	☐
15. CRM HMAC	☐	☐	☐
16.	☐	☐	☐
17.	☐	☐	☐
18.	☐	☐	☐
19.	☐	☐	☐
20.	☐	☐	☐

NOTE: Multiple selections per mix are allowed.

Comments:

A17. Service life

Indicate your opinion of mix service life i.e. service life before rehabilitation is required, where:

Low	=	0-5 years
Adequate	=	5 -10 years
Excellent	>	10 years

Mix	Low	Adequate	Excellent
~~01. Texas Type A~~			
~~02. Texas Type B~~			
03. Texas Type C	☐	☐	☐
04. Texas Type D	☐	☐	☐
05. Texas Type F	☐	☐	☐
06. SMA	☐	☐	☐
07. PFC (with CRM)	☐	☐	☐
08. PFC (without CRM)	☐	☐	☐
09. CHMB-C	☐	☐	☐
10. CMHB-F (with CRM)	☐	☐	☐
11. CMHB-F (without CRM)	☐	☐	☐
12. Superpave (12.5 mm)	☐	☐	☐
13. Superpave (19 mm)	☐	☐	☐
~~14. Superpave (25 mm)~~			
15. CRM HMAC	☐	☐	☐
16.	☐	☐	☐
17.	☐	☐	☐
18.	☐	☐	☐
19.	☐	☐	☐
20.	☐	☐	☐

NOTE: Base materials have been eliminated since these are not used for surfacings. Select only one option for each mix type.

Comments:

A18. Modifiers

Indicate performance grade (PG) modifiers used/considered for the listed mixes.

Mix	SBR (Latex)	SBS	Tire rubber	Elvaloy	EVA
01. Texas Type A	☐	☐	☐	☐	☐
02. Texas Type B	☐	☐	☐	☐	☐
03. Texas Type C	☐	☐	☐	☐	☐
04. Texas Type D	☐	☐	☐	☐	☐
05. Texas Type F	☐	☐	☐	☐	☐
06. SMA	☐	☐	☐	☐	☐
07. PFC (with CRM)	☐	☐	☐	☐	☐
08. PFC (without CRM)	☐	☐	☐	☐	☐
09. CHMB-C	☐	☐	☐	☐	☐
10. CMHB-F (with CRM)	☐	☐	☐	☐	☐
11. CMHB-F (without CRM)	☐	☐	☐	☐	☐
12. Superpave (12.5 mm)	☐	☐	☐	☐	☐
13. Superpave (19 mm)	☐	☐	☐	☐	☐
14. Superpave (25 mm)	☐	☐	☐	☐	☐
15. CRM HMAC	☐	☐	☐	☐	☐
16.	☐	☐	☐	☐	☐
17.	☐	☐	☐	☐	☐
18.	☐	☐	☐	☐	☐
19.	☐	☐	☐	☐	☐
20.	☐	☐	☐	☐	☐

NOTE: Multiple selections are allowed. List additional modifiers and mixes these are used with in your comments.

Comments:

A19. Performance benefits of PG modifiers

Indicate benefits of PG modifiers as experienced.

Characteristic	SBR (Latex)	SBS	Tire rubber	Elvaloy	EVA
01. Rutting resistance	☐	☐	☐	☐	☐
02. Fatigue resistance	☐	☐	☐	☐	☐
03. Aging resistance	☐	☐	☐	☐	☐
04. Reflective cracking retardation	☐	☐	☐	☐	☐
05. Long term durability	☐	☐	☐	☐	☐
06. Improved bonding/adhesion	☐	☐	☐	☐	☐

NOTE: Multiple selections are allowed. Additional benefits may be added to your comments.

Comments:

A20. PG modifier content

Indicate whether modifier content is specified or based on that to obtain PG grade or both.

Modifier	Specified	Not specified
01. SBR (Latex)	☐	☐
02. SBS	☐	☐
03. Tire rubber	☐	☐
04. Elvaloy	☐	☐
05. EVA	☐	☐

Comments:

A21. Pavement structure

Consider the following pavement structures numbered 1 through 6, with numbered asphalt layers:

New construction: Structure 1: 1. AC surface 2. AC level-up 3. AC base course Granular layers	New construction: Structure 2: 1. AC surface 2. AC base course Granular layers	New construction: Structure 3: 1. AC surface Granular layers (flex base, stabilized layers and subgrade)
New construction: Structure 4: Concrete pavement 1. AC base course Granular layers	Rehabilitation: Structure 5: 1. AC surface Old flexible pavement	Rehabilitation: Structure 6: 1. AC surface Old concrete pavement

The page that follows requires response relating to these structures.

A22. Pavement structure (continued)

Indicate which of the listed HMA mixes are appropriate for the structures as outlined on the previous page.

Pavement Structure	1			2		3	4	5	6
AC Layer	1	2	3	1	2	1	1	1	1
01. Texas Type A		☐	☐		☐				
02. Texas Type B		☐	☐		☐				
03. Texas Type C	☐	☐	☐	☐	☐	☐	☐	☐	☐
04. Texas Type D	☐	☐	☐	☐	☐	☐	☐	☐	☐
05. Texas Type F	☐	☐	☐	☐	☐	☐	☐	☐	☐
06. SMA	☐	☐	☐	☐	☐	☐	☐	☐	☐
07. PFC (with CRM)	☐	☐	☐	☐	☐	☐	☐	☐	☐
08. PFC (without CRM)	☐	☐	☐	☐	☐	☐	☐	☐	☐
09. CHMB-C	☐	☐	☐	☐	☐	☐	☐	☐	☐
10. CMHB-F (with CRM)	☐	☐	☐	☐	☐	☐	☐	☐	☐
11. CMHB-F (without CRM)	☐	☐	☐	☐	☐	☐	☐	☐	☐
12. Superpave (12.5 mm)	☐	☐	☐	☐	☐	☐	☐	☐	☐
13. Superpave (19 mm)	☐	☐	☐	☐	☐	☐	☐	☐	☐
14. Superpave (25 mm)		☐	☐		☐				
15. CRM HMAC	☐	☐	☐	☐	☐	☐	☐	☐	☐
16.	☐	☐	☐	☐	☐	☐	☐	☐	☐
17.	☐	☐	☐	☐	☐	☐	☐	☐	☐
18.	☐	☐	☐	☐	☐	☐	☐	☐	☐
19.	☐	☐	☐	☐	☐	☐	☐	☐	☐
20.	☐	☐	☐	☐	☐	☐	☐	☐	☐

NOTE: Surfacing options have been removed for base materials. Multiple selections are allowed.

Comments: