



**Lockwood, Andrews
& Newnam, Inc.**
A LEO A DALY COMPANY

November 5, 2020

Mr. John Nowak, P.E.
Engineer
City of Schertz
10 Commercial Place, Bldg 2
Schertz, TX 78154

RE: 2018 SPAM chip Seal Study

Mr. Nowak:

Lockwood, Andrews & Newnam, Inc. (LAN) was contracted by the City of Schertz for performing a study on the 2018 SPAM chip seal projects and providing recommendations to mitigate the existing issues including chip loss, raveling, and rough ride.

LAN performed site visits on many of the 2018 SPAM chip seal projects and collected about 100 chip samples from the following streets:

- Fawn Dr
- Antler Dr
- Sophie Marie
- Gwendolyn Way
- Hiram Lane
- Lincoln Dr
- Patrick Henry
- Robert Stevens
- Will Rogers
- Village Oak
- Cloverleaf
- Forest Way
- Curtis

LAN also reviewed the contractor's submittal for emulsified asphalt binder and aggregates used in the 2018 SPAM chip seal projects. LAN was not present during the construction; our findings are only based on the contractor submittal (Appendix 'A') provided by the City and site visits we performed in October 2020. The followings describe our findings in two areas: findings related to the design of chip seal and findings from field visits.

1- Findings from Design:

2.1 Emulsified asphalt binder:

The emulsified asphalt product used in the 2018 SPAM chip seal projects is HFRS-2P which is a very common product for chip seal application and has shown promising results in the past few years. LAN reviewed the contractor's submittal and did not find any issues with that.

2.2 Aggregate Gradation and Size:

Reviewing the contractor's submittal for the aggregates, the following table was developed for the retained aggregates on each sieve which is the aggregate grade 5 in TxDOT item 302:

Table 1- Aggregate gradation

Sieve Size	Retained %
1/2" (25mm)	0
3/8" (19mm)	4.2
1/4" (6.3mm)	51.2
#4 (4.75mm)	22.2
#8 (2.36mm)	21.3
#16 (1.18mm)	0.1
#50 (0.3mm)	0.4

As can be seen in Table 1, aggregates mainly consisted of four different sizes (3/8", 1/4", #4, and #8), however, the TxDOT manual recommends using only one single size of aggregates for chip seal projects. In most of the successful chip seal projects in collectors/arterials, the aggregate size is 3/8", and for residential streets, the recommended aggregate size is 1/4".

2.3 Flakiness of aggregates:

To achieve a consistent embedment depth, aggregates better to be more cubical than being elongated and flat. The flakiness index plays an important role in the performance of a chip seal project. The contractor's submittal does not show the flakiness index but according to the chip samples collected, the flakiness index of aggregates seems to be high. Figure 1 shows the samples collected from Gwendolyn Way. As can be seen, most of the samples are very flat and elongated.



Figure 1- Chip samples from Gwendolyn Way

2.4. Percent embedment of aggregates:

The percent embedment depth, a few weeks after the construction, should be a minimum of 50% with the desired amount of 70%. In this study, the embedment depth of sampled aggregates was measured using a digital caliper. For some streets such as Gwendolyn Way in the Estates at Wilson Preserve, Fawn Dr and Antler Dr in Deer Haven neighborhood in which a high amount of raveling and chip loss was observed, the average measured embedment depth was between 20% to 30%. On the other hand, this number was found to be from 55% to 65% in a few streets including Robert Stevens, Will Rogers, Cloverleaf, and Forest Way where zero or a very light raveling was observed.

The low percent embedment can be a result of low asphalt binder application rate or poor compaction. There are two phases of compaction in chip seals; the first phase is the initial compaction by roller and the second phase is the final compaction caused by traffic. Small dead-end streets do not have enough traffic to compact the chips sufficiently, therefore, a higher binder application rate is required for those streets. Figure 2 shows the positions of aggregates throughout the compaction phases.

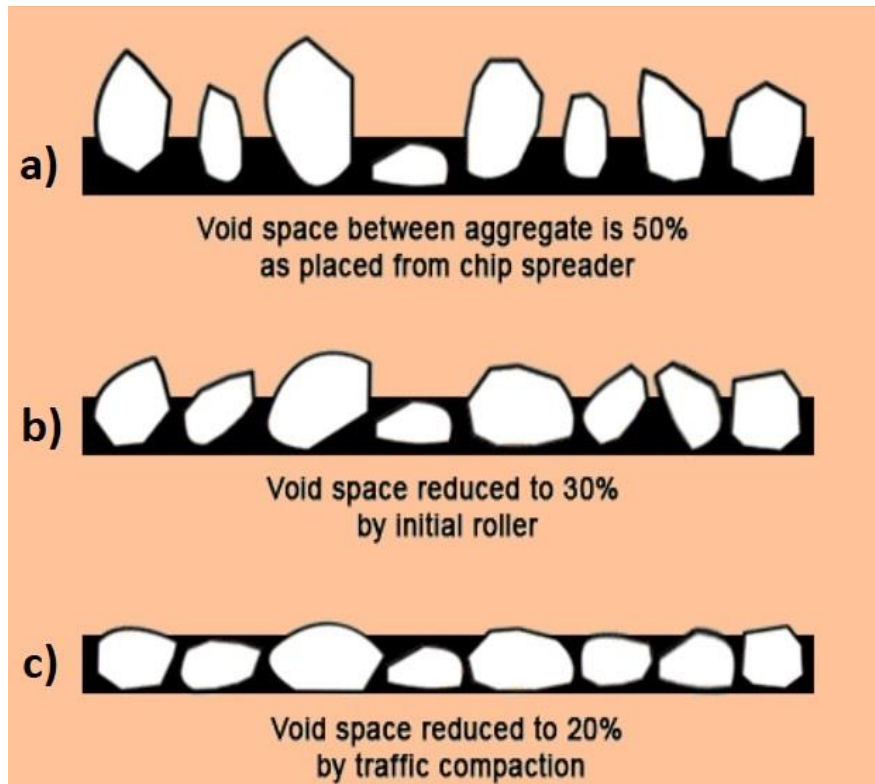


Figure 2- compaction phases of chip seals

3. Findings from Site Observations

LAN performed a few site visits to evaluate the current condition of the 2018 SPAM chip seal projects. We found many streets with a medium to a high amount of raveling and chip loss where the underlying pavement surface was exposed to the extent of about 5% of the whole street area. Those streets are mainly in the Deer Haven neighborhood and The Estates at Wilson Preserve Neighborhood. However, we found many streets in the Greenfield Village neighborhood such as Robert Stevens, Will Rogers, and Lincoln Dr to be in acceptable condition with zero to very light raveling. Also, many streets in the Lone Oak neighborhood including Cloverleaf Dr, Forest Way, and Valley Oak Dr also appear to be in an acceptable condition. We also drove Curtis Ave, but due to the on-going construction on the street, we were not able to evaluate the street condition, but we anticipate a high amount of raveling on this street in the future due to the heavy construction equipment moving on the street. The following explains our findings where severe raveling has occurred.

3.1. Nonuniform application of asphalt binder:

As can be seen in Figure 3, there are many parts of the streets where the old pavement surface is fully exposed without the presence of emulsified asphalt binder. Figure 3(a) shows parallel lines with aggregate loss along the street. This can be due to equipment (distributor) nozzles not being calibrated or adjusted. Almost in all streets with regular cul-de-sacs or elbow-type cul-de-sacs, nonuniform application of asphalt binder was observed. This resulted in zero to low asphalt binder in some areas and excessive asphalt binder in some other areas in the vicinity (Figures 4 and 5).



Figure 3- Exposed pavement surfaces on chip seal projects



Figure 4- Excessive asphalt binder (Flushing) at cul-de-sac – Sophie Marie

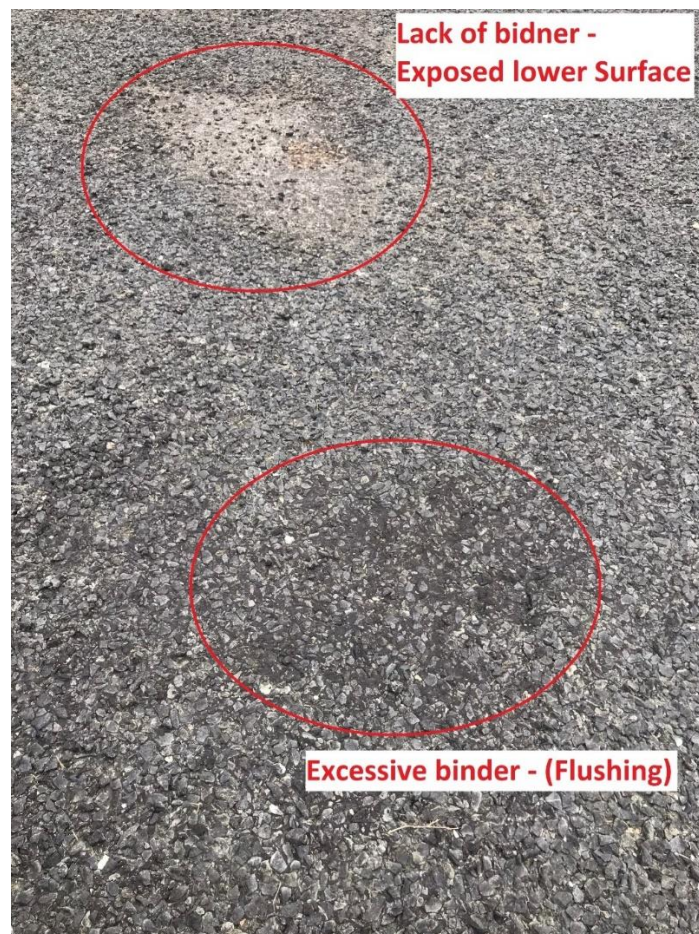


Figure 5- Nonuniform asphalt application - Hiram Lane

In these cases, initially, only a few chips will be missing, then it becomes a progressive issue. The loss of these few chips seriously weakens the shoulder-to-shoulder bracing of the chips, which is as important as the grip of the binder in holding the chip in place. The result is more chip loss that further weakens the seal. In any road with significant traffic, the whole process can progress from 1% or 2% loss to complete chip loss over half or more of the surface in a matter of weeks or over several months.

In many streets in the 2018 SPAM Chip Seal, the street slopes down from the cul-de-sac up to the intersection. As mentioned earlier, the highest amount of chip loss occurs in cul-de-sacs and due to the slope of the street, chips get moved to the other end of the street resulting in loose chips all over the street.

3.2. Dirt and dust between chip seal and the old pavement layer:

In a few cases such as Antler Dr, Fawn Dr, and Forest Way dust and some organic materials were observed underneath the chips. It might be due to poor surface preparation prior to the application of binder and chip seal.

3.3. Compaction:

As mentioned in section 2.3, a good portion of aggregates in streets with a high amount of raveling seem to be not fully sitting on their flattest side. According to site observations, most of the aggregates are positioned similarly to what is shown in Fig 2(b). Under traffic movement, aggregate particles will rotate until they sit on their flattest sides. That is why it is recommended to start chip seal projects in the early construction season, so it allows chips to rotate while the binder is soft during the hotter weather.

3.4. Intersections:

According to the field observation, almost in all intersections, the lower pavement surface was exposed which is due to the stop-start traffic, particularly on up or downhill sections of roads, and heavy braking and acceleration. Technically, these areas need more attention during the construction in terms of asphalt application rate and compaction.



Figure 6- Severe chip loss at the corner of Gwendolyn Way and Hiram Lane

3.5. Rough ride:

The ride quality on the new chip seal projects is always rough and is not comparable to the smoothness of the ride on hot mix asphalt pavement. But, as vehicles utilize the new chip seal surface the aggregate will begin to weather, rounding off the rough edges and changing its appearance. The ride quality of each street will start to get smoother, but this change depends on the Surface Aggregate Classification (SAC) of aggregates used in these projects. If aggregates with SAC A were used, it would take more time for aggregates to be rounded off. No information regarding the SAC of aggregates was found in the contractor's submittal.

3.6. Other factors:

There may be other factors affecting the performance of the chip seal. However, as LAN was not present during the construction, and was not provided with the construction observation reports, it is difficult to comment on that. Those factors are listed below:

- Cold weather affecting binder characteristics, e.g. sealing in late summer, cold overnight temperatures.
- Wet weather affecting binder characteristics during and after sealing.
- Lack of diluent or adhesion agent.
- Sealing over poorly constructed pre-reseal repairs.

- Cold binder.
- Dirty chip or wet chip
- Binder oxidation.
- Dry pavement that absorbs some of the emulsion intended for the new seal coat.
- Failure to timely apply the chips after applying the binder/emulsion.

4. Recommendations

4.1 Recommendations to mitigate the issue on the existing chip sealed streets

As mentioned earlier, there are a few design-related and placement issues that caused some streets in the 2018 SPAM chip seal to suffer from chip loss. Once chip loss starts it can increase very rapidly because of a lack of support from the surrounding chips. Once the shoulder-to-shoulder lock has been broken, the remaining chips tend to break away along the edges and this can rapidly deteriorate into wholesale stripping. This will get worse in the first winter after sealing when the binder is cold and brittle, and the chip has still not been fully compacted by traffic. Usually, the chip loss occurs right after construction is related to construction deficiencies, e.g. dirty chip, lack of adhesion agent, etc.

For streets with light raveling, LAN does not recommend any treatments at this moment as we believe the chip loss would stop soon. On streets with medium to high raveling, our short-term recommendation is to apply a slurry seal over the existing chip seal. The final product is called Cape Seal. We also recommend applying a fog seal or tack coat on cul-de-sacs prior to applying the proposed slurry seal; this can provide a better bonding and would prevent delamination in the next few years.

The long-term solution is milling out the existing chip seal in addition to about 1” of the old pavement and place 1.5” of a HMA overlay. This method would cost more than the first proposed method (applying slurry seal), but the final product would last much longer.

4.2. Recommendations for future projects

LAN does not recommend the chip seal application within the city limits due to the post-construction issues and its rough ride. We recommend the following applications for residential streets based on the pavement condition index (PCI) ranges:

Table 2- Proposed pavement applications for different ranges of PCI

PCI Range	Proposed Treatment
96-100	No application
91-95	Crack Seal
86-90	Fog Seal
81-85	Slurry Seal
71-80	Micro-surface
41-70	Mill and Overlay
0-40	Reclamation/Reconstruction

Should the City of Schertz decide to continue using the chip seal treatment for future projects, LAN recommends considering the following:

- 1- Chip seal is only recommended on streets where the PCI is above 75. Signs of rutting, fatigue cracking, and base failures on the street indicate that the street is no longer eligible for preventive maintenance.
- 2- Minimize using the chip seal on cul-de-sacs. The slurry seal can be a better application in this case.
- 3- A modified local design would be required for future projects in the City.
- 4- Use of a pre-seal can significantly improve the performance of the chip seal projects.
- 5- Having an inspector in the field during construction to make sure all requirements are met.
- 6- Start construction in late spring so that chips can easily rotate during summer and sit on their flattest side.

Attachments:

Attachment 'A' (Contractor Submittal)

Product: HFRS-2P

Description:

A high-float, polymer-modified anionic water-based emulsified asphalt product primarily used for chip seals.

Properties:

Boiling Point	212°F
% Volatiles	None
Appearance	Brown Liquid
Flammability	Non-flammable
Density	8.4 lbs/gal
Solubility	Soluble in Water
Odor	Petroleum Odor

Specification: TxDOT Std Specification Item 300

Property		Test Procedure (AASHTO)	Specification	
			(min)	(max)
Viscosity, Saybolt-Furol, 122°F, sec		T72	150	400
Sieve Test, %		T59		0.1
Demulsibility, 35 ml 0.02 N CaCl ₂ , %		T59	50	
Storage Stability, 1 day, %		T59		1
Distillation Test	Residue by distillation, % by weight	T59	65	
	Oil Distillate, % by volume	T59		0.5
Tests on Residue from Distillation	Polymer Content, wt. % (solids basis)	Tex 533-C	3	
	Penetration, 77°F, 100g, 5 sec	T49	90	140
	Float Test, 140°F, sec	T50	1200	
	Solubility in Trichloroethylene, %	T44	97.0	
	Ductility, 39.2°F, 5 cm/min, cm	T51	50	
	Elastic Recovery, 50°F, %	Tex 539-C	55	
	Viscosity, 140°F, poise	T202	1500	

Handling

Protect Emulsion from freezing
 Avoid overheating
 Avoid excessive pumping with high shear pumps

Storage & Application

Storage Temperature (°F) 50 – 185
 Application Temperature (°F) 110 - 160



Basic Quality Statistical Summary Report

Plant 360-Knippha Quarry
Product 625-Traprock Gr. 5
Specification TxDOT 302 Gr 5_2004
Period 10/01/2019 - 12/06/2019

Sieve/Test	Tests	Average	St Dev	Target	Specification
1" (25mm)	9	100.0	0.00		
3/4" (19mm)	9	100.0	0.00		
1/2" (12.5mm)	9	100.0	0.00		100-100
3/8" (9.5mm)	9	95.8	1.02		95-100
1/4" (6.3mm)	8	44.6	5.57		
#4 (4.75mm)	9	22.4	4.37		20-50
#8 (2.36mm)	9	1.1	0.55		0-2
#16 (1.18mm)	1	1.0			
#50 (0.3mm)	1	0.6			
Pan	9	0.00	0.000		
Coarseness Factor	9	4.2	1.03		
Workability Factor	9	1.1	0.55		
Grad Loss	9	-0.003	0.0093		
D10 (ES)	9	3.20	0.175		
D15	9	3.80	0.321		
D15/D85	9	0.44	0.034		
D50	9	6.53	0.307		
D60	9	7.09	0.258		
D85	9	8.69	0.149		
Cc	9	1.20	0.055		
Cu	9	2.22	0.105		
FM	9	5.77	0.062		

Query Query Selections
 Date Created 12/06/2019
 Date Range 10/01/2019 - 12/06/2019
 Plant Knippha Quarry