FHWA North Dakota Division Process Review Program

Review of Statewide Procedures for

ASPHALT CRACK SEALING OPERATIONS

September 2005

By:
Kevin J. Michel
FHWA ND Division

Table of Contents

Purpose of Review

The purpose of this review, Asphalt Pavement Crack Sealing Operations In North Dakota, is twofold. The first is to study past, current, and establish future methods of maintenance activities as they relate to Asphalt Crack Sealing. Secondly, to give a summary of which Crack Sealing Operations and Application methods are viewed to be more effective than other similar methods used by the NDDOT maintenance personnel.

Some results and recommendations of this review are subjective such as certain personnel's view of ease of application or what that person may believe outperforms another method; while other results and recommendations are objective such as core samples showing cracks that have been treated by certain methods and the performance and effectiveness of the materials use in sealing of those cracks at the time of the core was taken.

The following are general activities that were performed in the development of this review:

1. Identify past, current, and future NDDOT procedures that have been, are, and will be used for asphalt crack sealing operations.
2. View previous core sampling and summarize visual testing procedures completed in 2004.
3. Make recommendations on frequency of maintenance activities.
4. Make observation on performance to date of specific crack sealing application methods.
5. Recommend future practices.

Work Plan

The work plan was comprised of literature review, interviews with various NDDOT maintenance personnel, field reviews, review of current national best practices, and evaluation and observation of previous core samples done by the NDDOT. Figure 1 represents the schedule of events that occurred during the data collection and process review process.

ID	Task Name	Start Date	End Date
1	Personnel Interviews	4/1/05	8/31/05
2	Review Core Samples	5/1/05	6/1/05
3	Literature Review	6/15/05	7/30/05
4	Interviews/DataCollection	7/1/05	8/15/05
5	Write Report	7/17/05	9/15/05
6	Continue Evaluation/ Monitor	9/15/05	Future

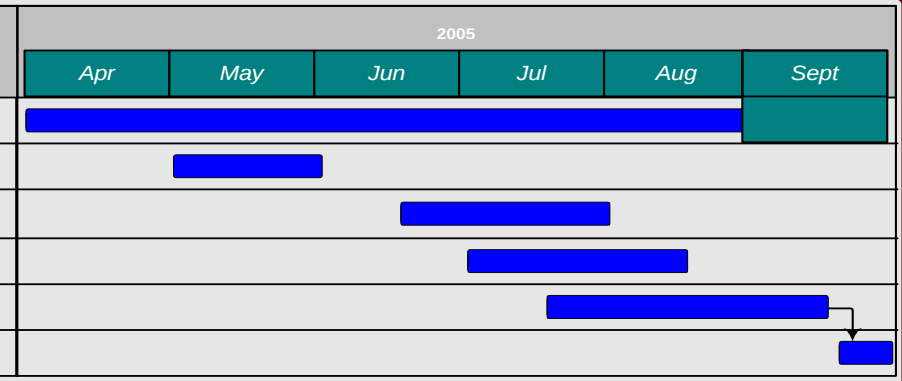


Figure 1 – Work Plan

Scope of Review

The scope of this review is limited to the information gathered from various sources within the NDDOT and is not intended to be a policy, rule, or even a guideline. It is solely the summary and observations given certain questions posed to persons within the NDDOT. The questions were posed to either the personnel actually doing the Crack Sealing Operations or someone from whom these personnel take day-to-day direction and/or recommendations such as Central Office personnel and or District management personnel. Information and other data shown in this report could be inferred to be current practices but not necessarily best practices. Results or recommendations listed also may be inferred to show future direction of the NDDOT with the information they currently have in their possession.

Review Personnel

The following people were involved in the information shown in this report:

Mr. Jerry Horner, Maintenance Engineer, NDDOT Central Office
Mr. Dave Levi, Maintenance Division, NDDOT Central Office
Mr. Michael Kisse, Maintenance Division, NDDOT Central Office
Mr. Clayton Schumaker, Materials and Research, NDDOT Central Office
Mr. Mike Hoff, Maintenance, NDDOT Dickinson District
Mr. Gary Feist, Maintenance, NDDOT Bismarck District

Executive Summary

Road construction within North Dakota is primarily limited to reconstruction, rehabilitation, and maintenance activities. All of these activities ultimately lead up to the level of performance an asphalt pavement will operate at before, during, and after maintenance activities are performed on any given stretch of roadway. This review will look at the past, present and future methods of crack sealing operations used by the North Dakota Department of Transportation (NDDOT) maintenance personnel statewide. General guidance is available to the maintenance personnel both developed locally or statewide; and nationally accepted treatment methods. Consistency of methods between NDDOT Districts and the personnel performing these maintenance activities has varied widely in past years and although methods are converging amongst the Districts several different and distinct methods are still being performed with mixed success.

This review will evaluate what crack sealing methods perform, have performed, or are expected to perform well within the state. Additionally, recommendations will be made and explained in detail.

Since education and methods of application of crack sealing are still being developed nationally, certain methods that work in one part of the country may not work well in other parts of the country and therefore, NDDOT practices do not necessarily represent the current best practices nationally, but rather the best practices that the District maintenance personnel feel work for their section of the state.

Crack Sealing Practices in North Dakota

Maintenance operations that are performed on North Dakota's road network include preventative maintenance (which typically includes crack sealing operations), corrective maintenance, and emergency maintenance. These three maintenance operations can either be done under contract using the design-bid-build process awarded to a contractor typically by low bid means, or by NDDOT personnel. Preventative pavement maintenance, specifically crack sealing operations, as referred to in this report will specifically address maintenance done by NDDOT maintenance personnel.

Preventative maintenance treatments are typically performed early in the life of a pavement (approximately 2-5 years) and then are scheduled for additional treatments on a somewhat regular basis (approximately 3-6 years) which will delay and retard deterioration affects such as oxidation, joint deterioration, subgrade saturation, and friction loss. The alternate would be to build a roadway segment and allow it to age with minimal maintenance until a significant corrective action would be required, or to rebuild the same section of roadway due to excessive degrading of the condition of the pavement. Life-cycle costs show that preventative maintenance performed on roadways throughout the life of the pavement is less expensive than letting the roadway degrade to the point of needing reconstruction. Examples of asphalt preventative maintenance strategies include chip sealing, thin lift asphalt overlays, microsurfacing, and the process detailed in this report of crack sealing. Other methods exist but are not widely used in North Dakota. The following graph shows the life-cycle of a typical pavement and the benefits of preventative maintenance.

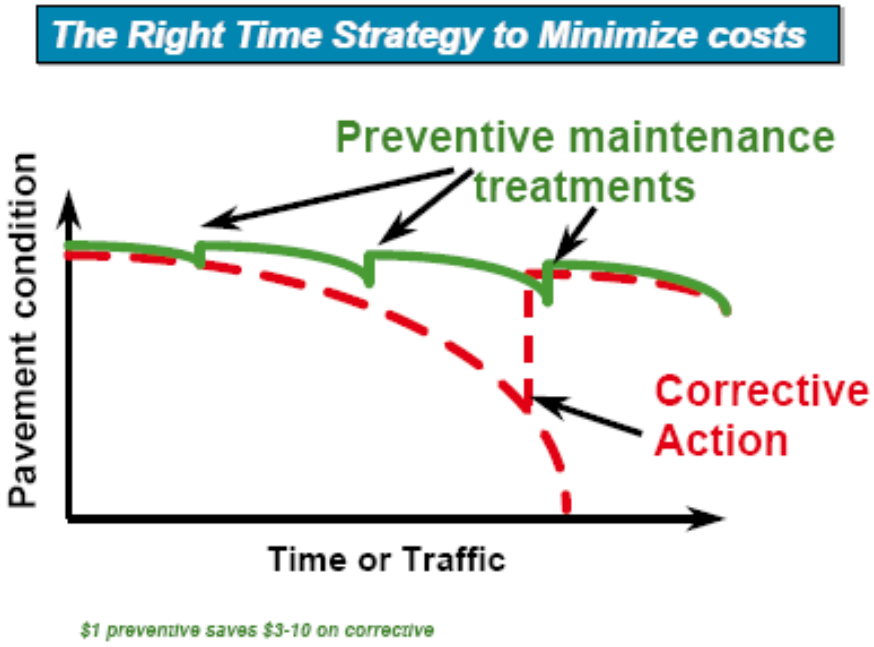
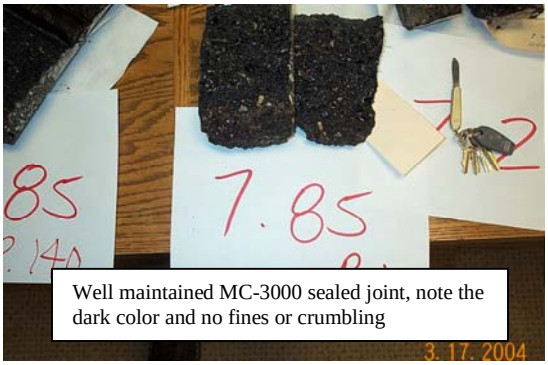


Figure 2 – Benefits of Preventative Maintenance Strategies

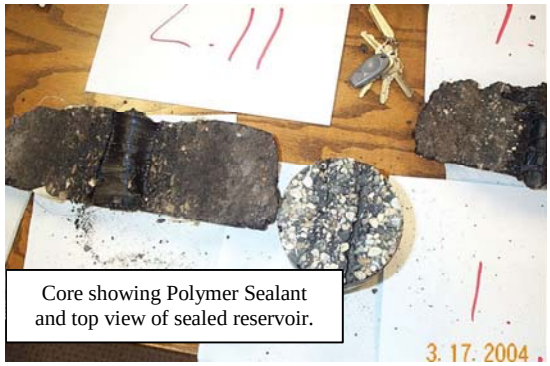
The NDDOT currently uses three specific and distinct application procedures for crack sealing operations depending on a number of variables including traffic volumes, age and condition of the roadway, available funds, and material availability. These three crack sealing applications consist of

- "cutback" asphalt (MC-3000)
- polymer modified asphalt (used for route and seal operation)
- crumb rubber sealant (used for process locally referred to as "blow and go", i.e., clean crack with forced air, seal crack with crumb rubber compound)

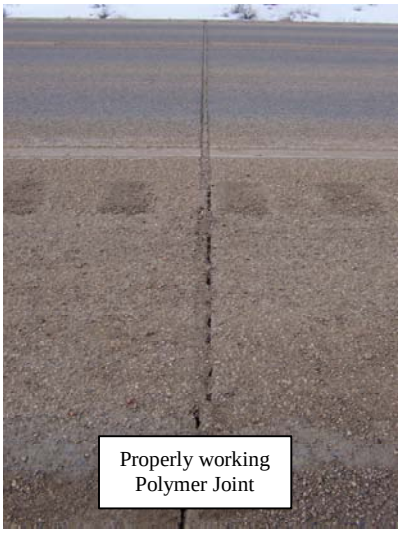


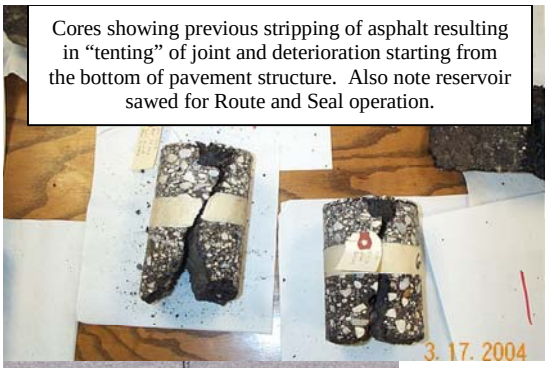
Well maintained MC-3000 sealed joint, note the dark color and no fines or crumbling

All three applications satisfy the crack-sealing goal of sealing the crack and preventing debris and moisture from entering the pavement structure. When preventative maintenance is not completed and moisture and debris (dust, sand, rocks, and other deleterious materials) are allowed to enter the unavoidable cracks in the pavement, damaging processes occur including stripping, spalling, and saturation of the subgrade. These processes in-turn result in progressively worse pavement performance by promoting erosion of the granular base material and the tendency for the face of the crack to be brittle resulting in "tenting" of the pavement. "Tenting" is the erosive removal of the asphalt pavement in a shape of an inverted "V" due to the loss of pavement flexibility causing voids under the surface of the pavement at the crack that is not usually initially visible at the pavement surface. Regular preventative maintenance crack sealing operations can significantly postpone or even completely avoid these negative affects on the pavement structure resulting in a longer lasting roadway at a lower cost for the users of the States infrastructure investment.

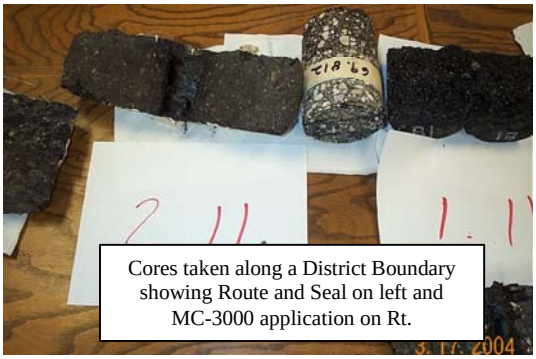


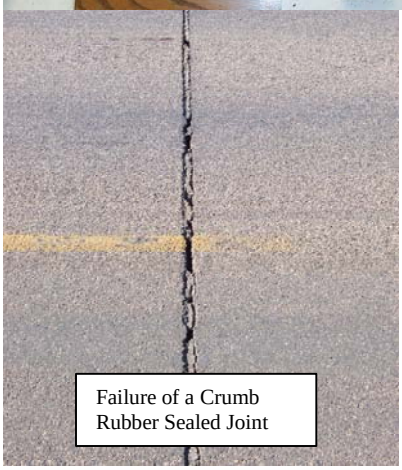
Core showing Polymer Sealant and top view of sealed reservoir.


Properly working Polymer Joint



Cores showing previous stripping of asphalt resulting in "tenting" of joint and deterioration starting from the bottom of pavement structure. Also note reservoir sawed for Route and Seal operation.


Cores taken along a District Boundary showing Route and Seal on left and MC-3000 application on Rt.


Failure of a Crumb Rubber Sealed Joint

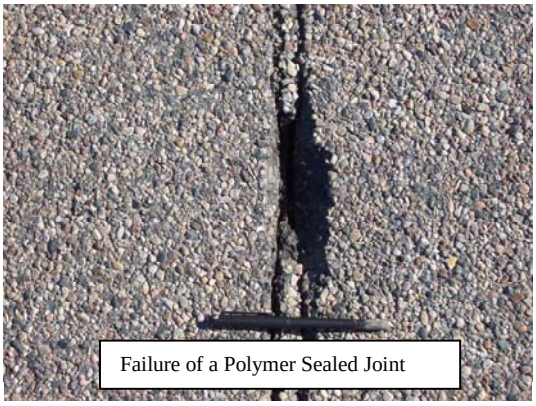
Joint showing irregular maintenance depicting inadequate amounts of oil deposited into joint not getting full coverage of joint face.

For an accurate picture of where the NDDOT has been in the past with the crack sealing practices, it is necessary to better understand why the current practices as stated above are in use. The timeline is briefly explained below.


Core showing brittleness developing in joint face causing damaging deterioration of the joint.

1. Current Crack Sealing Practices:

The need for consistency in fiscal management, material usage, application methods, and education and training has propagated the need to streamline the processes used in today's crack sealing operations. The individual Districts have until recently been allowed to function and maintain their individual District Road network as they deemed appropriate by whatever means they felt best fit their conditions. For example, crack sealing in one district under certain specific pavement conditions and criteria may be maintained by way of "cutback" asphalt using MC-3000 (crack "pouring") while other districts within the state given the same set of variables and road conditions may treat the roadway using a polymer or crumb rubber sealing operation (crack sealing). Although this method gave the Districts the needed flexibility to be able to maintain roads at the time and by methods that they decided to be appropriate, this also allowed for the wide variations in methods used for given circumstances. These variations also resulted in the use and trial of these crack-sealing applications in different statewide climates, geographical regions, and laydown methods. This allowed a learning environment amongst the Districts on what works well and what may not. With this information, an effort to streamline and a desire to make consistent logical decisions between districts is explained below in "Future Crack Sealing Operations".


Failure of a Polymer Sealed Joint


Cores showing comparison of well maintained poured crack with MC-3000 (left) & poorly maintained poured crack (right) showing exposed, dry joint face.

2. Past Crack Sealing Practices:

Operations for crack sealing in past years (over 15 years ago), were considerably less focused on Pavement Preservation and Preventative Maintenance, and instead, in many cases, were considered to be "build it and leave it until it needs to be re-built again". Because of this, crack sealing was done too late in the life of the pavement, frequency and material used for these applications varied significantly, or was not done at all. When crack sealing was done, occasionally the materials used were applied inconsistently, for example, some districts used an RC-800 oil that is high in Diesel Oil content which causes brittleness and ultimately will cause degradation of the pavement structure at the crack. This change in philosophy towards preventative maintenance has lead to pavements lasting considerably longer relative to the significant increase in traffic volumes and vehicle axle weights that drive the NDDOT Roadway system today.

3. Future Crack Sealing Practices:
The attached memo to Gary Berreth (Director of Office of Operations including Maintenance, Construction, and Civil Rights Engineering Services) from Dave Levi (Maintenance Engineering Services) explains the proposed recommendations to streamline the crack sealing operations amongst the Districts personnel. This proposal will still allow the flexibility the Districts need in their operation, while educating these same personnel on when and where a certain crack sealing application should be used.

Observations and Recommendations

The majority of the following observations and recommendations have been submitted to upper management at the NDDOT for inclusion into their Operations and Maintenance Manual, and if accepted, would be used as typical guidelines and established procedures for field maintenance personnel in selecting the appropriate preventative maintenance application. These observations and recommendations are taken from the memo as stated above sent to Garry Berreth from Dave Levi.

As briefly explained in the previous section "*1. Current Crack Sealing Practices"*, an additional explanation of the definitions of crack seal pouring and crack seal sealing is described in the aforementioned memo. The fine differences are critical to understand the observations and recommendations listed below.

1a. Observation:

Stripping of the cracks occurs below the top of the wearing surface and is sometimes not visible until advanced deterioration of the crack has occurred.

1b. Discussion:

Stripping is the process referred to previously as "tenting". This is typically caused from moisture entering the cracks and either through the freeze/thaw process or long-term saturation, which erodes the pavement from the bottom towards the surface.

1c. Recommendation:

Require all future Hot Bituminous Pavements (HBP) to use an anti-strip agent, unless testing shows that the performance graded (PG) asphalts used on the project will not have a stripping problem. This anti-strip agent that is added to the oil mix retards this deterioration (such as brittleness) by keeping the pavement flexible longer resulting in a longer lasting more durable pavement structure.

2a. Observation:

Newer pavements were not receiving preventative maintenance techniques at all or were being applied too late in the life of the pavement.

2b. Discussion:

A statewide standard practice will allow the pavements to be utilized to their full potential resulting in monetary savings to be used elsewhere in the state maintenance budget.

2c. Recommendation:

Seal/pour cracks in new hot bituminous pavement within the first three years after the pavement is placed. Cracks that are more than 3/4" wide shall be poured.

3a. Observation:

On new construction, reconstruction, or mine and blend projects, the investment to construct this type of project can be significant and to protect this investment, additional preventative maintenance procedures and activities need to be in place that currently do not exist.

3b. Discussion:

Education regarding the benefits of preventative maintenance needs to be taught early and often instead of waiting until the roadway is built and the maintenance of this roadway rests on the District personnel. When "buy-in" of this philosophy is done roads will last longer and the need for new or reconstructed roadways will be reduced.

3c. Recommendation:

On new construction, reconstruction, or mine and blend projects the transverse cracks should be sealed/poured early in the life of the pavement, that is, within 3 years after construction. These projects should also be monitored every other year after the initial cracks are sealed/poured so all new cracks are treated. Poured cracks should be retreated every other year.

4a. Observation:

Sometimes the incorrect process is used to treat a crack in the pavement depending on what method may have been done in the past and how well that previous method performed.

4b. Discussion:

Performing the wrong corrective measure can result in additional or unwanted crack failures and a uniform decision process to ensure the proper measure is critical.

4c. Recommendation:

On thin lift overlay projects where the pre-overlay transverse cracks were poured, the reflective cracks should be poured every other year. If the cracks in the old existing pavement were sealed in the past, the reflective cracks in the new overlay should also be sealed rather than poured. The District Engineer (DE) has the option to seal the transverse cracks if an aggressive crack pouring program was used and cores have been taken to show there is no stripping at the crack in the existing pavement structure.

5a. Observation:

A plan to treat asphalt pavement cracks that have not been previously treated needs to be instigated to prolong the remaining life of the pavement.

5b. Discussion:

A plan to treat previously untreated pavement cracks will re-emphasize the need to treat all pavement and not necessarily only high volume/high profile roadways.

5c. Recommendation:

On existing pavements, where the transverse cracks have not been sealed in the past, the cracks should be poured. If cores indicate there is no stripping, the DE should have the option of sealing the crack or continue to pour the crack every other year.

Conclusion

Although it is apparent that certain specific treatments between crack pouring with MC-3000 or crack sealing with a polymer or rubberized asphalt both have benefits in their own use, it is difficult to tell at this time which choice will operate better long term. Because of this, both options will continue to be used within North Dakota and future analysis will need to be performed to evaluate the performance of these products.

The efforts to *formalize* these recommendations resulting in the efficient and accurate completion of the ongoing crack sealing operations and standard procedures within North Dakota will most likely occur quickly; while the effort to put these recommendations into practice will most likely take some time. With education of the maintenance and management personnel of the background, logic, and economics behind this practice, the State of North Dakota will have a longer lasting roadway infrastructure to serve the traveling public for years into the future.

References

U.S. Department of Transportation, Federal Highway Administration (June 2003) Distress Identification Manual for the Long-Term Pavement Performance Program, Washington, D.C.

Transportation Research Board, National Cooperative Highway Research Program (2004) NCHRP Report 523, Optimal Timing of Pavement Preventative Maintenance Treatment Applications Washington, D.C.

U.S. Department of Transportation, Federal Highway Administration (November 2001) Pavement Preservation Checklist Series, 1. Crack Seal Application, Publication No. FHWA-IF-02-005 Washington, D.C.

U.S. Department of Transportation, Federal Highway Administration (1999) Materials and Procedures for Sealing and Filling Cracks in Asphalt Concrete Pavement, Manual of Practice Publication No. FHWA-RD-99-147 Washington, D.C.

National Cooperative Highway (1998) Thin Surfaced Pavements. Synthesis of User Practices, NCHRP Synthesis 260 Washington, D.C.

NDDOT (August 2003) Maintenance and Operations Manual Bismarck, ND

U.S. Department of Transportation, Federal Highway Administration (August 2000) Selecting a Preventative Maintenance Treatment for Flexible Pavements, Publication No. FHWA-IF-00-027 Washington, D.C.

National Cooperative Highway (2004) Public Benefits if Highway System Preservation and Maintenance, NHRP Synthesis 330 Washington, D.C.

National Cooperative Highway (2005) Chip Seal Best Practices, NCHRP Synthesis 342 Washington, D.C.

Attachments

Attachment A

Memo from Dave Levi to Gary Berreth requesting approval of crack sealing recommendations as standard procedures to be included into the Maintenance Operations Manual.

Attachment B

Memo from Mike Hoff, Dickinson District on summary of seminar presented by Crafco on Crack Sealing Operations.

Attachment C

Email from Gary Fiest, Bismarck District on summary of current District practices of Crack Sealing Operations.

Attachment D

North Dakota Department of Transportation Job Special Provision for Joint Sawing and Sealing on Project AC-NH-7-085(028)126, dated April 17, 1998

Attachment E

Memo from Ron Horner, Materials and Research Division of the NDDOT on summary of Crack Maintenance Study-Moisture Contents.

Attachment F

Graph showing typical refining process to develop varying types of asphalts.

ATTACHMENT A

MEMORANDUM

To: Gary Berreth
Director of Operations

From: Dave Levi
Maintenance and Engineering

Date: August 15, 2005

Subject: Crack Sealing Study

Recommendations to develop a crack sealing/pouring program were sent to the District on June 14, 2005. Comments regarding the crack sealing/pouring study were received from 5 of the 8 Districts. The initial recommendations were as follows:

Recommendations:

The terms sealed cracks and poured cracks in the following recommendations need to be defined to avoid any confusion.

Sealed cracks are those that are sealed with a polymer or crumb rubber.
Poured cracks are those that are poured with MC 3000 or another acceptable asphalt product.

1. Require all future HBP to use an anti-strip agent, unless testing shows that the new PG asphalts will not have a stripping problem.

2. On new or mine and blend projects the transverse cracks should be sealed early in the life of the pavement, suggest within 3 years after construction. These projects should also be monitored every other year after the initial cracks are sealed so all new cracks are sealed.

3. On thin lift overlay projects the reflective cracks should be poured every other year. If the cracks in the old existing pavement were sealed in the past, the reflective cracks in the new overlay should also be sealed rather than poured. The DE should have the option to seal the transverse cracks if an aggressive crack pouring program was used and cores have been taken to show we have filled the voids in the old existing pavement structure.

4. On existing pavements, where the transverse cracks have not been sealed in the past, the cracks should be poured. If cores indicate there is no stripping, the DE should have the option of sealing the crack or continue to pour the crack every other year.

Comments:

The following comments were received from the Districts regarding the recommendations made to the Departments crack sealing/pouring program.

Bob Walton:

I thought the document was well thought out and covered multiple considerations very well. I'll add a couple thoughts that you may wish to consider or discard.

In Fargo we have had success with routing or sawing asphalt for the first seal application. We also use a polymer when we rout or saw. I think Mn/DOT has specifications on routing, and is studying what size reservoir works best.

We have also found that if a crack is wider than 1", crack pouring is the best treatment. Crumb rubber won't work very well as it is usually applied when the crack is tighter, and then in the winter it opens so wide that the crumb rubber fails.

That is about all we had to add. Thanks for the opportunity.

Walt Peterson

The use of cutback oil from years back definitely degraded the cracks by striping from the bottom up. We have not milled any roadway that used crumb rubber or polymers. Milling gave us a view of the cracks from the side. Removing slabs would probably do the same.

If you have ever watched a train go over ties that were not on solid rock ballast, you can see how the ties pump fines. As the axle distributes load over the ties, the ties depress, water & fines splash out, the load passes over, the rail returns to proper elevation, until the next axle depresses the tie again. My point is that that same series of loading appears during spring thaw. That's when we see the moisture from the cracks and it's dirty dirt color.

I think if we start early in process, we get ahead of the early deterioration of the subgrade, and the cracks aren't as big. The joints that we sawed (& polymer sealed) on US 85, south of Watford City, were in good shape prior to our first seal, after about 4 years.

Larry Gangl

I have no comments.

Jerry Miller

Our District has sawed and sealed all new structural overlays and mine/blend projects since the early 1990's. We are sawing a ¾ x ¾ inch vessel and filling with polymer + over banding. This program has been quite successful when used on new pavements within 3 years after construction. There is always a follow up on all these projects within 2 years to saw and fill any new developed transverse cracks. Unless new guidelines are developed by MESD that require all districts to follow, our district intends to continue this method of crack maintenance.

It is our belief that the best method of maintaining thin lift overlays over old asphalt is either pouring with MC3000 or crumb rubber. Our district has a three year scheduled rotation for crack pouring on old asphalt surfaces throughout the district. We intend to experiment more with pouring transverse cracks using crumb rubber. This method will seal and fill depressed cracks.

Paul Regan

Use MC-3000 for all HBP crack maintenance.

Polymers and routing just provide a new crack next to the one that you seal with a polymer as it is stronger than the adjoining pavement.

Over banding with crumb rubber can cause striping of the asphalt beneath crumb rubber next to the asphalt joint as moisture moves up during the spring and fall due to capillary action.

We have had both situations happen with polymers and crumb rubber. We do not use either material for crack maintenance as they are more detrimental than helpful.

Lime is a wonderful product and has many uses. Injected into a new crack will probably cause the joint to raise rather than stay at the same elevation as it is expansive over time. This has happened to us on lime treated bases and resulted in costly joint repair contracts, milling projects and HBP overlays. It may be a good tool to consider for depressed joints.

Recommend that we use MC-3000 exclusively for HBP crack maintenance until a better method is found.

Revised recommendations based on comments received:

The terms sealed cracks and poured cracks in the following recommendations are defined as follows:

Sealed cracks are those that are sealed with a polymer or crumb rubber. Routing or sawing of the cracks may be used in conjunction with sealing at the discretion of the District Engineer.

Poured cracks are those that are poured with MC 3000.

1. Require all future HBP to use an anti-strip agent, unless testing shows that the PG graded asphalts used on the project will not have a stripping problem.
2. Seal/pour cracks in new hot bituminous pavement within the first three years after the pavement is placed. Cracks that are more than 3/4" wide shall be poured.
3. On new or mine and blend projects the transverse cracks should be sealed/poured early in the life of the pavement, suggest within 3 years after construction. These projects should also be monitored every other year after the initial cracks are sealed/poured so all new cracks are treated. Poured cracks should be retreated every other year.
4. On thin lift overlay projects where the existing transverse cracks were poured, the reflective cracks should be poured every other year. If the cracks in the old existing pavement were sealed in the past, the reflective cracks in the new overlay should also be sealed rather than poured. The District Engineer has the option to seal the transverse cracks if an aggressive crack pouring program was used and cores have been taken to show there is no stripping at the crack in the existing pavement structure.
5. On existing pavements, where the transverse cracks have not been sealed in the past, the cracks should be poured. If cores indicate there is no stripping, the DE should have the option of sealing the crack or continue to pour the crack every other year.

If you concur in the revised recommendations, please sign and return this memo. The Maintenance Operations Manual will be updated to reflect these procedures.

_____ _____

Concur Date

ATTACHMENT B

Crack sealing seminar

On March 8 I went to a crack sealing seminar in Fargo. It was put on by Crafco, so the information was presented in a very "Crafco-Promo way". However, there was a lot of valuable info presented that could be considered a standard industry wide.

The weather needs to be 40 degrees and rising to seal cracks with any of the asphalt sealants. All cracks must be clean and dry (our compressor needs a moisture trap installed). The width of the vessel to be routed is determined by the distance apart the cracks are. 30 to 40 feet is considered close cracks and the vessel need only be 3/4" by 3/4". As the distance between cracks gets greater, the vessel width must also increase to accommodate the increase in thermal cracking width.

All vessels must have an overband of material on both sides of the vessel to protect the top 90 degrees corners of the vessel from oxidizing and breaking away. The overband width was not determined. The overband thickness must be kept to a minimum because the plows will either shear it off or pull it loose from the vessel wall causing the sealant to fail. Care should be given not to rout the crack wider than necessary because it can cause ride problems, such as wheel slap.

Perhaps the most critical element of routing and sealing cracks is choosing the right material. There is well over 100 different sealants on the market to choose from, making selection rather difficult. From the information I got at the seminar, the softest, most pliable material that the climate will allow is probably best. It is important that the sealant not track when the temps climb in the summer, and still remain pliable enough to stretch in our sub-zero temps.

When pouring the sealant, many crews use toilet paper as a detack. Some manufacturers have a substance that can be sprayed on the material to prevent tracking. After talking with some of the guys there during coffee break, I learned that dish soap and water has the same affect.

Some discussion was done about failures. What exactly is considered a failure and what to do when they do fail? MinnDot has determined that if 10% of the crack reopens, either the sealant coming loose from the vessel wall, or thermal cracking reflection through the poured material, the entire crack is considered a failure. As far as what to do once the cracks have failed, the information I got from Crafco was wishy-washy and inconclusive. Taking the sealant completely out of the vessel and starting over would be the best scenario, but not very realistic because it is so very labor intensive. Plan (B) would probably be to go over the failed crack with a heat lance, then pour a band of sealant right over the failed material. This should not be done however, if the road has had a seal coat over the sealant. In that case, all you can do is blow the crack and put a band of sealant over it and hope for the best. In my opinion, not enough information is available for handling failures. Much consideration needs to be given to this because the life expectancy of crack sealants is much less than the life expectancy of the road they're poured on.

Some discussion was done on the pot life of Asphalt Crack Sealants. These materials should never be heated for long periods of time without being used. They will break down and began to set up in the melter-applicator. 12 to 15 hrs seemed to be a standard Pot life. I was impressed with the fact that they spent about an hour talking about safety around melter- applicators. I don't feel that I learned anything new, however it was a good review.

Mike Hoff
Dickinson section

ATTACHMENT C

Kevin, attached is comments from Bismarck District on their crack sealing practices. mjk

The response is from our Bismarck District Maintenance Supt. Let me know if you need more clarification on any item. Thanks mjk

1. What temperature range do you heat the material to?

2. What weather conditions do you have, at the time of application?

3. Do you air blow or heat lance the cracks?

4. How high do you fill up a crack (up to the top? 3/4 full? ½ full?)?

5. Do you always overband about 8", or is that only when minor secondary cracks are visible on the surface?

6. Do you try to select locations where mostly newer single cracks need to be treated (vs. areas were cracks are in bad shape and secondary cracking is visible)?

7. Any other thoughts?

1. We heat the oil to 290 degrees maximum and usually pour till it drops down into the 260-degree range. Then we re-heat. When to re-heat is also determined by how well the oil is pouring. The colder it gets it will stiffen and not pour well. Of course it is then time to re-heat.

2. The colder the better, less or no tracking when temperatures are low. We do not have to use a blotter sand when temperatures are low because there isn't any tracking. We use blotter sand when temps. get higher and tracking starts to develop. We have crack poured when it has been zero degrees and/or higher. The key is to crack pour when the cracks are open and they generally start to open in late December or January. Normally we do not get started until February.

3. We do not air blow or heat lance the cracks. We simply pour the MC3000.

4. We do not fill the crack at all. We make one pass over the crack to coat both faces of the crack wall and that appears to be sufficient. If you try to fill the crack the oil will come up and out of the crack when temps. warm and the crack goes back together.

5. The overband is always present from the squeegee which is on the back of the the tar pot. It happens because as we pour the oil it does not get down into the crack soon enough. Thus as we pour and squeegee an overband is created. This is good though because the overband does help with minor secondary cracking and also helps prevent spalling at the crack surface.

6. We crack pour every crack even the bad ones within reason. We have had good results doing this.

NORTH DAKOTA DEPARTMENT OF TRANSPORTATION

SPECIAL PROVISION

JOINT SAWING AND SEALING

ACNH-7-085(028)126

April 17, 1998

DESCRIPTION.

This work consists of saw cutting, cleaning, drying and sealing transverse joints into new bituminous pavement according to the plans and the NDDOT specifications.

MATERIALS.

Sealant. Joint material shall be a "Type 2 - Hot Applied Joint Sealant" and shall meet the requirements of Section 826, except modified herein.

EQUIPMENT.

General. The melting kettle shall be double jacketed boiler type, equipped with both agitation and recirculation systems capable of melting and applying the sealant through a pressure-fed hose and wand. The melter shall be capable of starting at ambient temperature and bringing the sealing material to application temperature in one hour or less, while continuously agitating and recirculating the sealant. The melter shall be equipped with automatic thermostatic controls and temperature gages to monitor the sealant temperature in the applicator lines and temperature of heat transfer oil in the kettle jacket.

The air compressor shall be capable of producing a continuous stream of clean, dry air through the nozzle at 87 psi (600 kPa) and 38 ft^3/ft (3.5 m^3/m) minimum. The compressed air unit shall be equipped with water and oil traps and must produce sufficient air volume and pressure to remove all debris from the sawed joint and all adjacent road surfaces in a safe manner such that the debris will not re-enter the joint prior to the sealing operation.

The heat lance shall operate with propane and compressed air in combination and be capable of achieving a heated air temperature of 1800 EF (1000 EC) at the exit orifice and a discharge velocity of 3280 ft/s (1000 m/s).

A self-propelled power saw capable of providing a straight cut of uniform depth and width shall be used. Diamond saw blades with either single or gang blade arrangement shall be used. The power saw shall cut in a downward motion. The saw blade or blades shall be of such size and configuration that the desired joint reservoir shape and deep saw cut are achieved in one pass of the saw. Two-pass cutting will not be allowed. No spacers between blades shall be allowed unless the Contractor can show that the desired reservoir and saw cut can be obtained with them.

CONSTRUCTION REQUIREMENTS.

General. The Contractor shall conduct the operation so that saw cutting of transverse joints, cleaning, and sealing are a continuous operation. Traffic shall not be allowed to knead together or damage the sawed joints. Sawed joints not sealed before traffic is allowed on the pavement shall be re-sawed, if necessary, at no additional cost to the NDDOT. The joints shall be sealed when the sealant material is at the pouring temperature recommended by the manufacturer. The contractor shall fill the joint such that after cooling, the sealant is flush with the adjacent pavement along the edges and the center does not sag more than 1/8" (3 mm) below the pavement of shoulder surface.

Care must be taken to ensure that the joints are not overfilled and the final appearance shall present a neat fine line. The applicator wand shall be returned to the machine and the joint sealant material recirculated immediately upon completion of each joint sealing. The Engineer may require a squeegee to force the material into narrow joint openings if, in the opinion of the Engineer, the material is not flowing into the joint properly. Sand shall not be spread on the sealed joints to allow for early opening to traffic. The sealant shall be tack free before opening to traffic.

A given quantity of sealant material shall never be heated at the pouring temperature for more than six hours and shall never be reheated. The contractor shall record the temperature of the kettle and the temperature of the sealant once every hour during sealing and shall report the temperatures to the engineer. Temperatures recorded more than 40 EF (4 EC) above the manufacturers specifications shall result in rejection of the material in use, and the contractor shall dispose of the overheated material in an acceptable manner.

Breaker Tape will be allowed on this project.

Sawing. Each joint shall be cut in one pass and meet the following criteria:

Each saw cut shall be either wet sawed with the following procedures used:

1. Flush the sawed joint with high pressure water until the water runs clear.
2. Clean and dry the joint with compressed air removing all loose material.
3. Heat the joint with a hot-air lance immediately before sealing.

Or dry sawed with the following procedures used:

1. Clean the joint with compressed air removing all loose debris.
2. Heat the joint with a hot-air lance immediately before sealing.

While heating pavement with the lance, be careful not to burn the pavement surface. No more than two minutes shall elapse between the time the hot air lance is used and the sealant is placed.

The contractor shall wait 48 hours, from the time the pavement was placed, before sawing the joints.

Weather Limitations. The weather limitations shall be specified in Section 826.01.

ACCEPTANCE.

Sealed joints shall be rejected if there is evidence of poor workmanship or obvious defects, such as, but not limited to the following:

1. Sawed joint not filled completely
2. Lack of bond to the sides of the joint
3. Excessive debris or moisture in the joint
4. Contamination of the sealant
5. Sawed joint not filled flush

Rejected sealed joints shall be repaired, the sealant removed and disposed of in an appropriate manner, and the joints resealed to the Engineer's satisfaction at no additional cost to the NDDOT.

METHOD OF MEASUREMENT.

This item will be measured by the lineal feet of sawed and sealed joints. Payment shall be full compensation for all labor, equipment, and materials necessary to complete the work as specified.

BASIS OF PAYMENT.

Pay Item	**Pay Unit**
Sawing and Sealing Joints	Linear Foot

ATTACHMENT E

MEMORANDUM

TO: Michael Kisse
Maintenance & Engineering Division

FROM: /s/Ron Horner
/s/Benjie Foss
Materials and Research Division

DATE: September 15, 2005

SUBJECT: Crack Maintenance Study-Moisture Contents

Introduction:

We have completed the soil moisture content portion of the Crack Maintenance Study. The objective of this moisture content investigation consisted of obtaining and comparing moisture contents from below predetermined cracks and from a location 5 feet away from the cracks.

Sampling & Testing:

A total of 204 soil samples were taken from the 34 pairs of boring locations, on 16 North Dakota highways. The sampling locations were provided to us by the Maintenance Division. At each of the locations a 1 foot, 2 foot, and 3 foot moisture content was obtained, although these depths are approximate due to the method of drilling (solid flight auger). The moisture content findings have been included in this report.

Observations:

No obvious differences were observed in the moisture contents of the sampled locations. When comparing the 1, 2, and 3 foot crack samples to the corresponding 1, 2, and 3 foot samples 5 feet away, we found that the majority of the moisture contents had a less than 2 percent difference. The 1 foot moistures should be compared cautiously due to the bottom of base/top of subgrade transition occurring at this depth in a number of borings. This may have caused us to sample the base at one hole, but then sample the subgrade at the corresponding hole, resulting in two incomparable moisture contents. Moisture infiltrating a poorly sealed crack probably does not reach the 3 foot depth due to the soil type and quantity of water; therefore the moisture contents at 3 feet may not be relevant for this study.

Conclusions:

Based upon this information alone, we are unable to draw a definite conclusion with respect to the effectiveness of the current crack sealing procedures in preventing moisture from infiltrating.

Other factors that should be considered for the overall crack maintenance study, but were not part of our investigation, are the age of the roadway, thickness of the pavement section, location of the roadway within the state (soil type), profile grade of the roadway, and information about the cracks. Some useful details about the crack are crack width, crack spacing, presence of a sealant, most recent sealing, condition of the sealant and type of sealing (i.e. rout and seal, hot poured, etc.).

Many of the roads in our state are replaced or improved, not because of deteriorated asphalt, but because of the deteriorated ride. We feel that the NDDOT's efforts should be concentrated in areas where a known problem exists, such as depressed or heaved cracks. We need to fully understand what factors contribute to the depression or heaving to understand what has to be done to correct the problem. The Geotechnical Section meets with Maintenance personnel on every job that we drill. Our observations indicate two things.

1.) There is very little consistency across the state, or in some case within the districts, on how crack are maintained. Many roadways we encounter have transverse cracks that have never been sealed with any type of sealant other than a chip seal, which is not elastic and only fills the cracks for the first season.

2.) When cracks are sealed, some current NDDOT methods are not as effective as others in maintaining long term resistance to infiltration. We feel that ride quality could be preserved considerably by instituting a crack maintenance program. A crack maintenance program would require installing a crack seal shortly after the formation of the crack and maintaining the crack seal for the life of the pavement. The type and interval of maintenance may vary with the age and quality of transverse crack.

It is our belief that water can infiltrate an unsealed crack, softening the subgrade below the cracks, which lowers the bearing capacity of the soil. If this occurs, depressed cracks can develop due to the lack of support beneath the roadway. Stripping of the asphalt due to the water ponding in the joints can also contribute to the formation of depressed cracks. We believe that an effective sealing procedure would help to prevent depressed cracks.

ATTACHMENT E

Highway 2

RP+Feet	Moisture Content		
	1ft	2 ft	3 ft
323+1024 (Crack)	15.2	11.8	32.3
323+1029	14.4	11.0	32.8

Highway 11

RP+Feet	Moisture Content			RP+Feet	Moisture Content		
	1 ft	2 ft	3 ft		1 ft	2 ft	3 ft
9+0206 (Crack)	22.8	21.8	15.2	69+4113 (Crack)	24.0	17.4	24.2
9+0211	22.4	21.2	17.7	69+4118	26.6	24.0	27.6
9+0399 (Crack)	17.8	23.9	18.5	73+1631 (Crack)	13.8	24.8	14.5
9+0405	22.1	21.3	19.3	73+1636	13.1	28.8	10.7
64+3522 (Crack)	13.5	11.5	28.1	76+3849 (Crack)	16.0	18.9	16.7
64+3528	11.7	12.2	26.6	76+3854	15.8	17.0	16.6

Highway 13

RP+Feet	Moisture Content			RP+Feet	Moisture Content		
	1 ft	2 ft	3 ft		1 ft	2 ft	3 ft
245+2054 (Crack)	15.3	13.0	30.6	250+3976 (Crack)	13.5	19.3	18.8
245+2059	12.3	11.7	29.4	250+3970	18.9	27.3	21.4
247+2408 (Crack)	20.0	20.1	18.4	255+2534 (Crack)	17.7	19.1	18.8
247+2413	19.1	14.7	14.7	255+2529	16.5	12.8	24.2

Highway 17

RP+Feet	Moisture Content		
	1 ft	2 ft	3 ft
94+2993 (Crack)	25.0	28.2	29.5
94+2998	22.7	24.7	34.6

Highway 22

RP+Feet	Moisture Content			RP+Feet	Moisture Content		
	1 ft	2 ft	3 ft		1 ft	2 ft	3 ft
60+1605 (Crack)	7.7	8.6	14.8	48+3273 (Crack)	4.7	8.1	23.8
60+1610	4.8	5.6	16.1	48+3278	6.7	8.4	26.0

Highway 26

RP+Feet	Moisture Content			RP+Feet	Moisture Content		
	1 ft	2 ft	3 ft		1 ft	2 ft	3 ft
1+0064 (Crack)	25.5	23.5	27.3	7+3627 (Crack)	18.7	18.8	23.0
1+0069	25.1	24.5	30.2	7+3632	18.3	11.7	23.0
3+4778 (Crack)	13.6	34.3	17.9				
3+4784	24.6	33.2	17.0				

Highway 31

RP+Feet	Moisture Content		
	1 ft	2 ft	3 ft
78+2344 (Crack)	26.6	22.6	26.0
78+2349	28.4	25.1	28.0

Highway 32

RP+Feet	Moisture Content		
	1 ft	2 ft	3 ft
201+1478 (Crack)	20.3	26.1	27.6
201+1483	23.6	23.5	27.8

ATTACHMENT E

Highway 48

RP+Feet	Moisture Content		
	1 ft	2 ft	3 ft
0+3940 (Crack)	20.7	22.2	17.8
0+3945	19.9	22.2	20.5

Highway 49

RP+Feet	Moisture Content			RP+Feet	Moisture Content		
	1 ft	2 ft	3 ft		1 ft	2 ft	3 ft
49+2543 (Crack)	15.6	13.3	13.5	99+2666 (Crack)	14.9	18.4	18.4
49+2548	13.0	11.7	12.3	99+2671	15.8	17.9	17.3
67+1785 (Crack)	23.1	25.6	30.3				
67+1789	26.3	26.3	34.2				

Highway 52

RP+Feet	Moisture Content			RP+Feet	Moisture Content		
	1 ft	2 ft	3 ft		1 ft	2 ft	3 ft
214+5226 (Crack)	15.1	13.8	15.6	249+0359 (Crack)	18.7	14.8	20.7
214+5231	13.0	14.9	14.7	249+0364	17.2	14.4	20.1
245+4763 (Crack)	8.4	8.4	11.4	251+3443 (Crack)	14.0	11.2	18.9
245+4768	7.6	7.8	12.7	251+3448	16.1	16.6	17.2

Highway 58

RP+Feet	Moisture Content		
	1 ft	2 ft	3 ft
1+0000 (Crack)	13.1	9.9	14.7
0+5275	13.3	12.3	13.6

Highway 66

RP+Feet	Moisture Content		
	1 ft	2 ft	3 ft
128+0971 (Crack)	20.1	17.3	23.7
128+0976	19.8	19.0	23.7

Highway 67

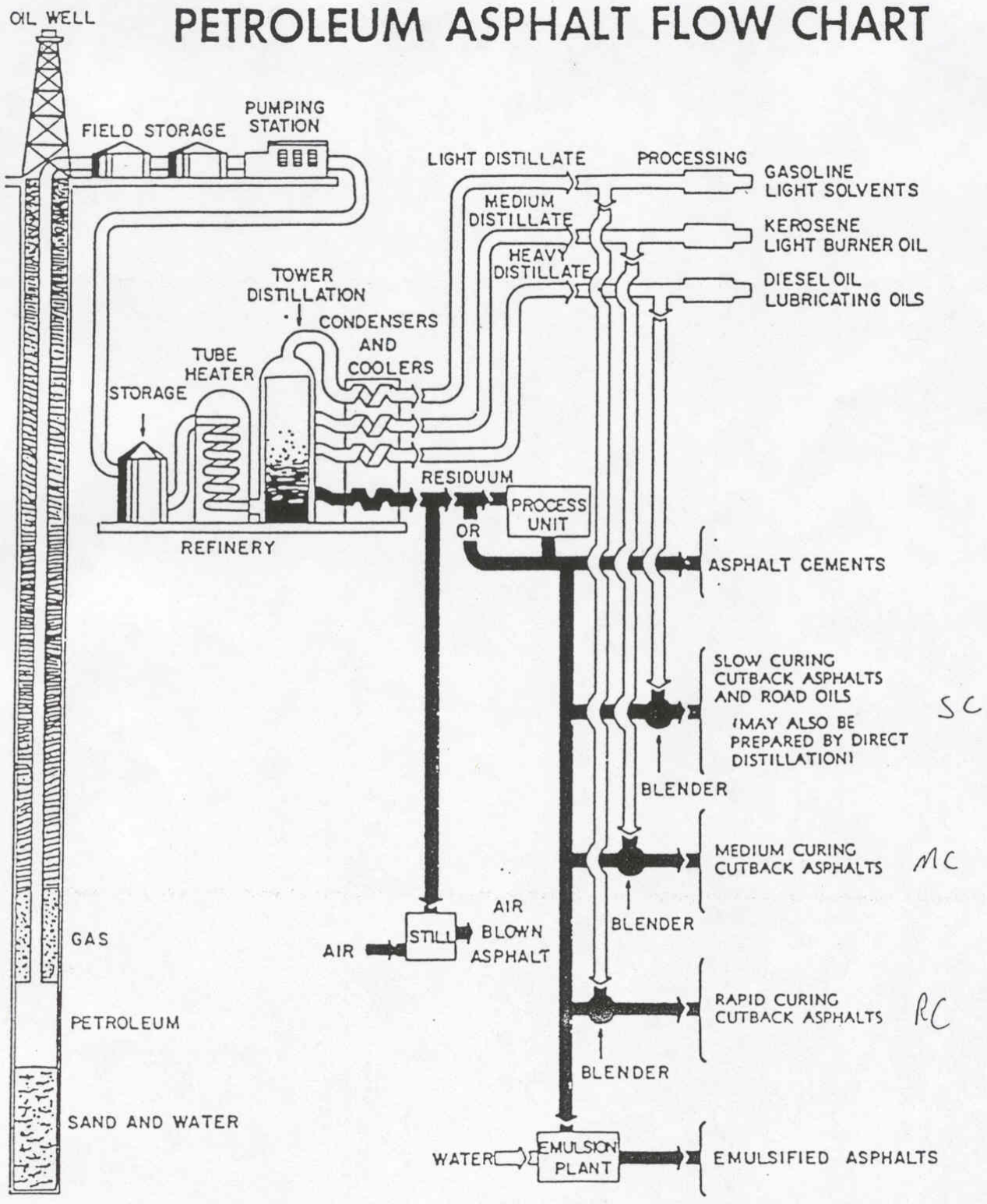
RP+Feet	Moisture Content		
	1 ft	2 ft	3 ft
0+3940 (Crack)	20.7	22.2	17.8
0+3945	19.9	22.2	20.5

Highway 85

RP+Feet	Moisture Content			RP+Feet	Moisture Content		
	1 ft	2 ft	3 ft		1 ft	2 ft	3 ft
130+2640 (Crack)	19.5	21.3	26.7	139+5275 (Crack)	9.7	7.3	10.0
130+2645	16.8	20.3	27.6	140+0000	9.0	6.9	8.3

Highway 200

RP+Feet	Moisture Content			RP+Feet	Moisture Content		
	1 ft	2 ft	3 ft		1 ft	2 ft	3 ft
1+0021 (Crack)	19.2	19.8	21.8	295+0000 (Crack)	9.1	9.1	15.0
1+0026	15.1	24.0	27.3	295+0005	6.6	6.1	12.2



Typical Refining Process.