Concrete Scaling and Deicing Position Statements

Positions of the Concrete Paving Industry in Wisconsin

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The following position statements were developed by the staff of the Wisconsin Concrete Pavement Association in 2009. They were developed in response to the significant number of projects that we were asked to review by cities, counties, the Wisconsin Department of Transportation and private property owners for the purpose of providing guidance as to the cause of the concrete scaling and providing recommendations on how to move forward. All of the projects reviewed were new concrete placed in 2007 and 2008 that experienced scaling through the very tough winters of 2007-2008 and 2008-2009. The vast majority of the scaling issues have occurred on driveways, sidewalks and curb and gutter.

The purpose of these position statements is to provide information and a framework to the concrete industry in dealing with these problems. The members of the Wisconsin Concrete Pavement association feel that there has been too much misinformation as to the cause and remedies. In addition several entities have made quick changes to specifications that we feel have not solved the problem and in some cases may make the potential for durability and scaling issues to increase.

The Wisconsin Ready Mixed Concrete Association has reviewed this work because of the similar problems that have occurred on exterior flatwork in their market areas. They have endorsed these position statements and will be implementing them into their technical programs and documents.

A companion document to this should be the "Municipal Concrete Pavement Specification" developed by WCPA and published in November, 2009. This document can be found on our website at www.wisconcrete.org.

All questions and inquiries in regards to these position statements should be addressed to:

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Written by the WISCONSIN CONCRETE PAVEMENT ASSOCIATION and endorsed by the Wisconsin Ready Mixed Concrete Association

POSITION STATEMENT #1:

Know the Concrete You are Buying

The quality and durability of the constructed concrete product cannot be improved upon until the contractor and owner know the concrete they are using along with its fundamental properties.

Just like any other consumer good that you purchase, you should know what you are buying when you are purchasing concrete. Too many times when the Wisconsin Concrete Pavement Association staff are investigating the cause of surface distress on a new piece of concrete, we ask about the concrete mix design and the in place quality of the concrete and the information is not known or available. Specifying good concrete to be used to build your street, parking lot, driveway, sidewalk or other exterior concrete and then assuring quality is a fundamental step to preventing surface distress in the form of scaling, mortar flaking, and chert or other popouts.

The State of Wisconsin Department of Transportation (WisDOT) is the largest purchaser of concrete in Wisconsin. Their specifications are very good and time tested. Purchasing concrete for your street and roadway projects that meet the requirements of Section 415 on Concrete Pavements and Section 501 on Concrete of the Standard Specifications for Highway and Structure Construction published annually by WisDOT will have you well on your way to owning long life concrete pavements, driveways, sidewalks, etc. Considerable time and effort is put forth by a number of concrete experts and engineers annually to assure that these specifications meet the needs of the Department. We recommend utilizing their time and experience to your advantage.

In addition to the WisDOT specification, the Wisconsin Concrete Pavement Association (WCPA) has developed a specification to be used on city and county projects. It is primarily based on the WisDOT specification, but can be more easily adjusted for smaller city or county paving projects.

Some general guidelines to follow:

1. Buy your concrete from a reputable and established concrete producer.
2. Ask the ready mix supplier if he is a member of the Wisconsin Concrete Pavement Association, American Concrete Pavement Association, National Ready Mix Concrete Association and/or the Wisconsin Ready Mix Concrete Association. While not true in all cases, companies with association ties are generally the more proactive and quality based producers.
3. Ask your concrete producer if the concrete being supplied used one of the following mix design tools:
    - American Concrete Institute Standard 211, “Standard Practice for Selecting Proportions for Normal Heavyweight and Mass Concrete”.
    - Portland Cement Association’s Design and Control of Concrete Mixtures
4. Require the producer to supply you with the concrete mix design to be used on your project and receive batch tickets or computer print outs of all concrete delivered.
5. Assure that your concrete meets a specification by doing quality control testing or require the producer to supply you quality assurance information.
    - For highway, roadway, street and runway projects the preferred specifications would be the WisDOT Standard Specification for Road and Bridge Construction or the specification developed by the WCPA for city and county road applications.
    - For private parking lots, driveways, sidewalks, etc. conformance to the *WisDOT specifications*, *WCPA specification or ASTM C94 – Standard Specification for Ready Mixed Concrete* will provide you with the assurance of quality concrete.

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6. Strength of the concrete and the air content will be affected each time the ready mix supplier adds water and retempers the concrete at the job site. This practice requires close monitoring in order to assure that consistent concrete is delivered from truck to truck.

Desirable Concrete Properties for Concrete in Wisconsin

1. Concrete has a minimum compressive strength at 28 days of 4,500 pounds per square inch or greater. Concrete needs a minimum strength to accommodate the loads that it will be impacted by. But in addition the concrete also needs strength to be durable. An additional strength parameter of 3,000 pounds per square inch is required for concrete to be opened to traffic that will carry trucks or other heavy loads. For light duty concrete that will be carrying automobiles or other light equipment, a strength of 2,500 pounds per square inch is acceptable.
2. Concrete has air entrained into it. The target air content should be 6 percent plus or minus 1.5 percent. WisDOT specifications require 7 percent air plus or minus 1.5 percent for concrete pavement placed by slipform methods. The air was increased for this application because it is believed that the intensive vibration and consolidation effort will take some air out of the pavement. A target of 6 percent air is adequate for all concrete placed by non-slipform or hand methods.
3. Concrete should have a minimum cement/cementitious content of 565 pounds for cubic yard. Wisconsin DOT specifications require a minimum of 70 percent of the material to be Portland cement. The remaining 30 percent of cementitious material can be fly ash or ground granulated blast furnace slag. The recently published WCPA specification reduces this percentage to 20 percent for municipal concrete pavement. Having this amount of material will assure two things. First, minimum strengths will be achieved. Second, this will assure an adequate amount of cement paste in the mix so that it is workable during placement and that a good finish is easily achieved. Many times when investigating concrete scaling issues, we hear that a 4,000 or 4,500 psi mix was used. We immediately ask what that means. We are not questioning that the strength of the mix was achieved. But, we are seeing mixes that have reduced cementitious contents that do not have a paste content that allow for them to be easily finished. So, the surface is overworked and water is added to the surface to facilitate finishing in order to achieve a good looking piece of concrete. This puts concrete at risk of scaling when it is in an exterior environment with significant exposure to deicing salts.
4. A maximum water-cement/cementitious material ratio of 0.45. Concrete placed by slipformed methods will have significantly lower ratios to accomplish the placement.
5. WisDOT does not allow for lower cementitious contents in their specification.
6. Lower cementitious contents can be used as long as the combined gradation of the aggregates is optimized as part of the mix design process.

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Position Statement #2

Proper Finishing is the Contractor's First Priority in Providing a Durable Surface

Additional focus and efforts on proper finishing is needed. In today's environment of the public requiring ice free concrete surfaces, the need for excellent finishing practices to be used is paramount to avoiding scaling and other surface distresses.

Finishing determines the final appearance, smoothness, and other surface properties of concrete that affect the long-term durability of a pavement surface. Concrete finishing is a critical step in the paving/placement process. In particular, we are focusing in on the hand finishing that is typically applied to obtain a smooth surface necessary to correct any unevenness behind the paver and or screed.

The need for concrete finishing is minimized by development of a workable concrete mixture and/or having properly operating paving equipment. Problems with finishing and closing the surface are indicative of mix problems associated the fine to coarse aggregate volume or paste volume too low, the paver needing adjustment, or the method of vibration/consolidation needing adjustment.

Some general guidelines to follow:

1. Concrete finishing efforts are to be kept at a minimum. Ideally, the concrete mixture being used will result in an acceptable surface finish behind the paver or screed.
2. The surface does not need to be completely tight and have every small blemish corrected. In most cases the final process of brooming or turf drag will remove most blemishes.
3. Do not apply water to the surface to aid in achieving blemish free surfaces.
4. Too much paste at the surface is a result of too much water applied to the surface, over vibration and/or over hand finishing**.** The result in each case is mortar at the surface that has low air and strength and reduced freeze-thaw durability.

The process of finishing include the following steps (as outlined by the ACI and CIP #14 from NRMCA):

1. Level the concrete further using a bull float, darby or highway straight edge. This process embeds the large aggregate, smoothes the surface, fills any apparent voids, takes out high spots and identifies the low spots for correction.
2. Wait a short period of time for the bleed water to come to the surface and the concrete begin to set. Working the bleed water into the surface will affect the durability of the surface concrete in the form of scaling. In paving operations where low slump concrete is being used there may be no bleed water, therefore no waiting period.
3. Perform all edging and required hand forming of joints.
4. Float the concrete one more time to remove any additional surface blemishes as much as possible.
5. Troweling is the next operation in the general finishing guidance. TROWELING OF EXTERIOR CONCRETE IS NOT RECOMMENDED. ACPA, PCA, NRMCA and ACI all state that troweling will remove air from the surface of the concrete reducing the surface durability. The use of steel trowels or fresnos is consistently referenced as a bad practice in freeze-thaw environments.
6. Texture the concrete with brooms or a turf drag to achieve the desired final surface finish. A perfect glass smooth finish free of voids is not required prior to the application of the final texture. The process of turf drag or brooming will close additional voids in the surface.

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Position Statement #3

CURING: Timeliness and Materials is the Key to Success

The quality of the curing operation and the material used significantly increases the durability of the concrete surface. Proper and timely curing are keys to preventing scaling and durability issues associated with the use of deicing salts.

Ask someone in the concrete industry the definition of curing and you will get something that resembles the following: Curing is the maintenance of adequate moisture and temperature regimes in freshly place concrete so that it can develop the properties the mixture was designed to achieve. The Integrated Materials and Construction Practices for Concrete Manual produced by the National Concrete Pavement Technology Center provide a very good introduction to curing. It reads as follows:

"Curing is the action taken to maintain moisture and temperature conditions in a freshly mixed concrete to allow hydration and pozzolanic reactions to proceed. Internal temperature and moisture directly influence both early and ultimate concrete properties. Proper curing measures prevent rapid water loss from the mixture and allow more thorough cement hydration. It is essential to apply curing measure as early as possible after placing concrete and to continue them until enough hydration has taken place that the required hardened properties have been achieved."

"Curing primarily affects the quality of the surface of the pavement, the zone that is impacted the most by the environment and loading conditions."

The key to preventing scaling of the surface of the concrete is to have a complete hydration (cement) and pozzolanic (fly ash and slag) reaction at the surface. This assures strong concrete and impermeable concrete. Concrete that has not been timely cured will dry out at the surface and a series of microcracks will form. The result is weak concrete and permeable concrete that will allow for moisture and deicing salts to damage the surface. Relative humidity and wind play a significant role in the timeliness of application of curing. General practice seems to be that the timeliness of cure is not an issue in the heat of the summer when we have warm days and high humidity. But, a more important condition of cooler temperatures, low humidity and stronger winds in the spring and fall of the year can produce more damage to the concrete if significant delays occur in the application of curing.

General guidelines for the use of liquid membrane curing compounds are as follows:

1. Do not apply the curing compound to concrete that is still bleeding or has a visible sheen of water on the surface.
2. Apply the curing compound immediately after texturing. Any delay, particularly during hot, dry, windy conditions, can cause significant harm to the concrete resulting in plastic shrinkage cracking. All ACPA, PCA and NRMCA information sources stress that the **curing should be applied immediately after the final texture of the concrete has been completed.**
3. Apply the curing compound uniformly to the concrete surface, ensuring that both the top of the slab and the sides are adequately covered. For curb and gutter construction, the front vertical face and back of the curb should be adequately covered. For fixed form paving, sidewalks and driveway construction, the vertical edges should be coated after form removal. Automated equipment is more effective at providing uniform coverage, and hand-operated equipment should be used only on small areas.
4. Recommended minimum curing compound application rates are:
    - 150 ft^2/gallon for tined concrete pavement and high early strength concrete pavement.
    - 200 ft^2/gallon for remainder of paving applications, curb and gutter, sidewalks, driveways, etc.
    - 100 ft_2/gallon for thin slabs, partial depth repairs and pavement repairs.

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The application rates should be periodically checked by measuring volume of curing compound applied to a given area and comparing that to the specified application rate.

5. Wisconsin DOT specifications indicate that the formal curing period ends at the point where the minimum 3000 psi compressive strength for opening to traffic is achieved.

2009 field reviews by WCPA staff can produce a number of good examples of curing. Unfortunately, we can also produce examples of poor curing practices. In both cases, the WCPA staff is working with the city where these pictures were taken on 2007 and/or 2008 scaling problems.

Picture #1: Timeliness of curing application. This concrete was placed early in the day and it was late afternoon before it was cured. You can see the color change where the concrete is drying out where the additional hand work was done next to formed joint in the curb and gutter.

Picture #2: Uneven coverage of curing compound. Being that this was a small piece of concrete a hand sprayer was most likely utilized. This entire piece should be completely white with no color changes to be uniformly and adequately protected from the impacts of deicing salts the first winter.

Picture #3 is a properly cured piece of concrete.

Picture #1

Picture #2

Picture #3

What is the proper curing compound to use?

In the recently published WCPA Concrete Pavement Specification Guide, version 2009, the curing materials recommended for municipal projects must conform to AASHTO M148 type 2 and be composed of a blend of boiled linseed oil and high viscosity, heavy bodied linseed oil emulsified in a water solution. These products are higher in quality than the standard water based white pigmented curing compounds traditionally used in Wisconsin. This product can be classified as a cure and seal product and provide short term protection of up to two years against the impacts of deicing salts. This short term protection will seal the pavement and allow the hydration and pozzolanic reaction to continue for the first two years of life before being significantly impacted by deicing salts. Further protection can be given by reapplying the products 28 days after placement to provide for a more complete longer lasting seal.

In addition to these products, WCPA is investigating the use of chlorinated rubber/epoxy and acrylic based cure and seal products. However, recent law changes in Wisconsin will limit the use of solvent based products. More time is needed for investigation prior to making further recommendations.

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Position Statement #4

SURFACE DISTRESS TYPES
Scaling, Mortar Flaking, Popouts and Chert

Accurately identifying the type and severity of surface distress present will improve the decision making process on whether further action is warranted by the contractor and the owner.

SCALING

Scaling is the loss of material in a finished surface of hardened concrete as a result of exposure to freezing and thawing, low air in the concrete and exposure to deicing chemicals. Generally, it starts as localized small patches which in more severe cases later merge and extend to expose large areas.

Light Scaling or Mortar Flaking

This type of scaling does not expose the coarse aggregate and appears as a very shallow loss of mortar in the surface. Mortar flaking becomes visible early in life because it includes the loss of the curing compound. This is purely aesthetic in nature and is not a progressive distress in that it rarely increases in severity or extent of the surface or continues to greater depths in the concrete. In most cases, the original mortar flaking disappears as the pavement ages, the curing compound is worn off the surface and traffic abrades the surface.

Moderate Scaling

This type of scaling exposes the aggregate and may involve surface loss of up to 1/8 to 3/8inch of the surface mortar. A majority of the time moderate scaling is localized and not predominant across the whole surface. This is indication of a problem that produced inconsistent finishing, addition of water to the surface in that localized area, inconsistent curing or a localized chemical attack. Repair of the surface is an option in this case.

Severe Scaling

In severe scaling more surface has been lost and the aggregate is clearly exposed and stands out. The term “peeling” of the surface can often be used because large chunks of mortar are coming off. This type of scaling is usually predominate across the entire surface. This is indicative of more severe problems and should be investigated. A range of repairs exist from concrete resurfacers, diamond grinding to complete removal and replacement of the concrete.

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POPOUTS

A popout is an isolated fragment that breaks out of the surface of the concrete, leaving a shallow, typically conical depression. Generally, a fractured aggregate particle will be found at the bottom of the hole. Aggregate sources containing an appreciable amount of shale or other shaly rocks, soft and porous materials, clay and certain types of chert have low resistance to weathering and should be avoided. These particles are often of lighter weight and float to the surface during vibration. The majority of the popouts occur during the first winter. A small percentage will occur over the next few years. No case of extensive popouts has ever been documented by Wisconsin DOT as a cause of reduction in life of the concrete. They are a non-structural and purely an aesthetic issue. Popouts are considered a cosmetic detraction.

CHERT

Chert is a lightweight porous aggregate that will cause a popout in concrete.

Picture #3: A chert popout
(courtesy of IMCP Manual, Page 50)

Picture #4: A popout over a piece of shale

MINIMIZING POPOUTS

Chert, shale and other soft particles naturally occur in our rock formations in Wisconsin. It is impossible and very costly to specify exterior concrete that will be 100 percent free of popouts. The Wisconsin DOT limits the amount of shale to 1% by weight of the coarse aggregate, Clay lumps to 0.3 %, soft fragments to 5% and Chert to 5%. The specification developed by WCPA reduces the amount of Chert to 3 percent. The intent of this specification is to be used in the urban environment, where the property owner is paying an assessment on the work. And, therefore for aesthetic reasons, we have elected to go to 3 percent to lower the chance of a chert popout because feedback in the urban environment indicates the 5 percent level is too much. At 3 percent prices will increase but is considered acceptable to avoid negative feedback from property owners. This level of chert should only be used for concrete paving specifications. Wisconsin ready mix concrete producers indicate that this level of chert with their limited aggregate sources and volumes would eliminate aggregate sources and/or be cost prohibitive. In addition, one of the keys to preventing popouts is not allowing water to sit on the concrete and saturate the surface; therefore proper cross slopes or pitch is required.

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Position Statement #5

DEICING SALTS
Their Role in Concrete Surface Distress

Deicing salts are playing a role in the increased frequency of durability related issues of concrete in the forms of scaling and other surface distress. WCPA recognizes that the use of deicing salts is a public safety issue. Therefore, our work will center on concrete mix design technologies and improving construction operations to prevent the scaling and surface distress from occurring.

Recent research conducted by Michigan Tech University for the South Dakota Department of Transportation, Michigan Department of Transportation and the Federal Highway Administration are all documenting that the new generations of deicing and anti-icing chemicals are playing a contributing role in surface and durability related distresses.

From the implementation guide for the research conducted by Michigan Tech University titled "The Deleterious Chemical Effects of Concentrated Deicing Solutions on Portland Cement Concrete:

> *Recent studies indicate that chemical alteration of the cement paste can also occur, resulting in dissolution of calcium hydroxide, coarsening of the concrete pore system and the formation of deleteriously expansive oxychloride compounds (Sutter 2008). This latter distress mechanism was identified when concrete laboratory specimens were exposed to concentrated solutions of calcium chloride or magnesium chloride. The solution strengths used in the referenced study were approximately 30-50% lower than the typical application strength of solutions used for anti-icing or deicing (Sutter 2008). Besides significant expansion and cracking, a significant loss in strength and degradation in freeze-thaw performance were also identified (Sutter 2008). In the same study, chemical deterioration of concrete was not found in, or was not indicated in, specimens exposed to highly concentrated NaCl solutions.*

The good news in this research is that the traditional and most widely used salt, sodium chloride, was found to not cause damage to quality concrete. The bad news is that the new pavement pre-treatment solutions and the solid salt pre-wetting solutions that are calcium chloride or magnesium chloride based are found to be chemically reacting with the concrete with the resulting in surface scaling.

The reaction that is being documented is the deicing salts chemically react with the calcium hydroxide ($Ca(OH)_2$) in the concrete. The $Ca(OH)_2$ is a byproduct of the cement and water hydration reaction and is present in all hardened concrete. The result is an expansive reaction that forms calcium oxychloride. This reaction forms microcracks at the surface which allows for further penetration of the deicing salts.

In the Michigan Department of Transportation study distressed areas showed a depletion of $Ca(OH)_2$. This is consistent with the Michigan Tech University study.

In addition research cited in the Michigan Tech University Study concluded the following:

> Deicer scaling/deterioration is more likely to occur in concrete that has been over-vibrated or improperly finished, actions that create a weak layer of paste or mortar either at or just below the surface (Mindess et al. 2003). This weakened layer is more susceptible to damage incurred due to stress generated by the application of deicers. However, even adequately properly finished concrete can be susceptible to the development of salt scaling if it possesses inadequate entrained air and/or is of poor quality.

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Significant findings of the research are also being documented in the area of the presence of moisture on the concrete during the freeze-thaw cycles. Concrete that is continuously wet through the freeze-thaw is at much higher risk of scaling. The freezing action drives the water and salt into the surface of the concrete. To prevent scaling all concrete surfaces should have the snow and ice completely removed after each storm event and the concrete surface allowed to dry.

This picture is an illustration of a property owner that struggled with snow removal over the last two winters. Two visible snow lines can be seen on the sidewalk. The area on the left scaled where snow was stored for a long period at the sidewalk transition away from the roadway. And, the area on the right scaled where the snow was left in place due to the large volume that needed to be moved because of the snow plows.

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Position Statement #6

FLY ASH and SLAG
A Key Role in Preventing Surface Distress Related to Deicing Salts

The pozzolanic reaction of fly ash and slag is the leading solution to providing protection against the destructive chemical reaction between concrete and deicing salts.

Fly ash and slag have long been documented as being beneficial supplementary cementitious materials in concrete. Increased strength and reduced permeability of the concrete are the documented advantages. Research across the nation has proven this over and over. Research conducted by James Parry at the Wisconsin Department of Transportation and Professor Steve Cramer of the University of Wisconsin has repeatedly confirmed that the use of fly ash and slag is beneficial to the strength properties, permeability and long term durability of concrete used in paving and other applications. It is this research that has shaped the Wisconsin DOT specifications that allow for up to 30 percent replacement of cement with fly ash and slag.

As the number of scaling issues have developed on new concrete sidewalks, driveways and curb and gutter due to the impacts of the severe winters of 2007-2008 and 2008-2009, a number of communities and contractors have implemented or are contemplating going back to cement only concrete mixes. Statements are being made that we never had any of these problems until we started using these products. WCPA is strongly urging people not to make these unscientific conclusions because they may be further jeopardizing the short and long term durability of their concrete. This is even more important as the Wisconsin DOT and the cities of Wisconsin continue to use deicing salts that are calcium or magnesium chloride based.

The research conducted at Michigan Tech University has documented that the deicing salts are reacting with the calcium hydroxide in the cement paste. This byproduct of the hydration reaction will always be present in concrete. The pozzolanic reaction that takes place in concrete occurs between the fly ash or slag and the available calcium hydroxide. The result of the reaction is the production of additional calcium silicon hydrates or the glue that gives us the strength and reduces the permeability. Through the Michigan Tech research we have one more beneficial reason to use fly ash and slag in that it reduces the amount of calcium hydroxide in the concrete and minimizes the reaction mechanism with the deicing salts being used.

As previously stated, the Wisconsin DOT allows for up to 30 percent replacement of cement with fly ash and/or slag. This specification was developed through research on concrete pavements. All pavements in the study were placed utilizing the extensive compaction and consolidation efforts of a slipform paver. We believe this is one of the reasons why the Wisconsin DOT projects experiencing concrete scaling are very rare. A vast majority of the concrete scaling issues have occurred on municipal projects on hand placed concrete (sidewalks, driveways and hand placed pavements). It is with this in mind along with feedback from member contractors and municipal engineers on strength, workability and callback or punch list issues that WCPA is recommending a maximum of 20 percent fly ash or slag replacement in the specification we have written for use by the cities and counties.

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Position Statement #7

YOUR CONCRETE IS ALREADY SCALED OR HAS POPOUTS
What are Your Options?

A majority of the scaling that has occurred in Wisconsin over the last two years does not jeopardize the structural integrity of the concrete, is not progressive and is purely an aesthetic issue. Therefore, removal and replacement is not required and there are alternatives to consider.

WCPA along with the contractors and cities has attempted to put science to work in the effort of finding the cause of scaling. This usually involves taking cores out of the concrete and sending them to a lab for a petrographic analysis. In a majority of the cases the petrographic results are inconclusive. Concrete that is mixed well with good air content is usually found. And, the argument continues. It is very difficult to determine absolute evidence to the cause of scaling and therefore responsibility for repair. It is with this in mind that WCPA is encouraging that the two parties come together in the spirit of compromise and teamwork in finding acceptable solutions other than the usual starting point of remove and replace.

The following alternatives are available for scaling problems:

1. **Do Nothing.** The light or low severity cases of scaling, also known as mortar flaking, are excellent candidates for doing nothing. In many cases after five years when the curing compound has completely worn off, environment has done its thing and traffic has abraded the surface, the visibility of the mortar flaking is no longer there. Moderate severity scaling that is localized and infrequent could also be considered here. These are small isolated areas that occur and there are no indications of pending larger quality issues with the concrete.
2. **Sealing the Concrete.** If the decision has been made to keep the concrete in place, the concrete can be sealed to prevent further damage to the concrete from deicing salts. There are many types of different penetrating sealers that are silane or siloxane based that will provide excellent long term protection of up to ten years or more. The concrete must be pressure washed to remove all loose material and completely remove the entire curing compound for these products to be effective.
3. **Grinding the Concrete.** Concrete pavements can be very easily diamond ground to remove the surface layer of the concrete to expose the sound concrete below. The traditional diamond grinding leaves a corduroy texture. This texture is very harsh for sidewalk and driveway applications and considered an unacceptable appearance by most property owners. The diamond grinding industry has flush grinding and grooved texture alternatives that can be considered for these applications. The flush grinding leaves a texture that is similar to an exposed aggregate look and it has been given favorable reviews. There are some concerns that this process produces an extremely smooth and slippery surface. So, an additional treatment like grooving to provide some macro-texture may be needed. This alternative should be used to address moderate and severe scaling problems.
4. **Resurface the Concrete.** WCPA has been working with member contractors and suppliers on the concrete resurfacing alternative. With the help of the City of Appleton we placed a product on a city street and driveway in 2008. It performed excellent through the winter of 2008-2009 and the encouraging results were the reason that Appleton moved forward with the application of a concrete resurfacers in 2009 on approximately 100 driveways that were installed during the 2007 construction season. These products have a couple of advantages. First, it gets the property owner back into their homes the same day and second the impacts of removals on landscaping and adjacent sidewalks, curb and gutter, pavement, etc. are not there. This alternative should be used to address moderate and severe scaling problems.

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5. **Remove and Replace.** If resolution cannot be found utilizing any of the other alternatives. However, WCPA recommends that this alternative only be used when it has been determined that the entire volume (not just the surface) of concrete has been documented to have low levels of entrained air.

The following alternatives are available for popout problems:

1. **Do Nothing.** Experience has been that the majority of the popouts that will occur will happen over the first winter. An additional small percentage will occur over the next few years. And, in year three to four the occurrence levels off and does not change over the life of the pavement. This is consistent with Wisconsin DOT findings as well. Aggregate sources meeting Wisconsin DOT or the WCPA specifications will not produce extreme levels of popouts. Use of WisDOT certified aggregates that meet the soundness, LA wear, freeze-thaw durability testing, gradation and deleterious material requirements is recommended for all concrete in Wisconsin to avoid popout issues.
2. **Sealing the Concrete.** The mechanism for popouts is water being absorbed in the porous and soft aggregate and the water expanding as it freezes. Sealing the concrete will not allow water penetration and will slow the development of popouts. When large amounts of surface area of concrete are part of a project, due to the cost of the recommended silane and siloxane based sealers this alternative is only recommended when it has been determined that aggregates were used that that will encourage popouts to occur.
3. **Resurface the Concrete.** In the case where there are an extreme number of popouts a concrete resurfacing concept could be considered. Cost effectiveness of the alternative needs to be investigated on large projects.
4. **GRINDING IS NOT AN ALTERNATIVE.** Grinding will only expose more aggregates acceptable to popouts and aggravate the problem.

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Position Statement #8

CONCRETE PAVEMENT SPECIFICATIONS
Establishing An Industry Standard in Wisconsin

Providing the most up to date and modern day construction specifications for concrete pavements to the cities and counties of Wisconsin will increase the quality of construction and inspection on paving projects.

Over the past couple of years we started monitoring which cities were building concrete pavements and the specifications they were using. The two most popular answers were we are using the Wisconsin Department of Transportation's specification or we have our own specification. Most people felt that use of the Wisconsin DOT specification was safe, but the specification was too big and their city was not able to do all of the quality control/assurance required of them in the specification. The review of those cities that were using their own was that majority of them were outdated and people were asking us for help to bring their concrete pavement specification up to current standards and practices. In both cases, the staff at the Wisconsin Concrete Pavement Association (WCPA) felt these specifications were costing the cities money. This was because our member contractors were not bidding the same concrete from city to city; some specifications were more than what was needed to accomplish the work and new materials, equipment and processes were not allowed.

WCPA has completed the development of the "Wisconsin Concrete Pavement Specification Guide" to be utilized by the cities and counties of Wisconsin when building concrete pavements. We believe that it has a number of advantages for you as a city to incorporate into your concrete paving projects. First, it is our goal that it becomes a standard in Wisconsin municipalities. Contractors love standardization, predictability, etc. It lowers their risk and ultimately their costs for doing the work. Second, the specification is adaptable to your city and staffing budgets. If you have the staff to do construction inspection and traditional quality control testing you use one part of the specification. If you do not have the staff or expertise available you can insert the provisions for the contractor to provide all of the quality control testing for you. This is consistent with the current practices of the Wisconsin DOT.

Finally and what we believe is the most important reason to use the WCPA specification, it is a collection of what we believe are the best practices in the construction of concrete pavement. When you consider the impacts of the past two winters, the ever increasing demand for salt usage and clear streets during the winter months, providing durable long lasting concrete that does not scale or spall and assuring the long life that people expect from concrete, we believe this specification will provide what cities in Wisconsin need.

Written by the WISCONSIN CONCRETE PAVEMENT ASSOCIATION and endorsed by the Wisconsin Ready Mixed Concrete Association