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Anti-Icing Pavement Coating Study at Chicago O'Hare International Airport

March 2007

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16. Abstract

Airports generally use two common strategies for keeping snow and ice buildup on aircraft movement areas to a minimum. The practice of anti-icing is primarily preventive, where the formation or development of bonded snow and ice is minimized by timely applications of a chemical freezing-point depressant (FPD) in advance and sometimes during each winter precipitation event. Deicing on the other hand is a primarily reactive practice because the FPD is not applied until snow or ice has already accumulated and formed a bond to the pavement surface. There are advantages and disadvantages to both practices. Anti-icing has the potential of lower costs due to less chemical being used than in deicing; however, a more systematic approach is often needed. Deicing may demand less upfront planning but usually requires a larger quantity of FPD to work its way through the snow pack to reach the snow/pavement interface and destroy or weaken the bond.

A promising new pavement coating claims to offer unique anti-icing characteristics that have the potential to reduce the costs and environmental impact associated with airport pavement anti-icing. The coating claims to require the application of less quantity of FPD chemical over multiple winter storm events compared to amounts necessary for typical airport pavement surfaces. The coating is a permanent treatment consisting of epoxy adhesive and porous aggregate chips applied to existing pavement surfaces. Additionally, the durability and friction characteristics of the coating are claimed to be comparable to typical airport pavements.

The purpose of this study was to evaluate the effectiveness of the anti-icing coating in terms of its anti-icing performance compared to adjacent pavement surfaces that did not have the coating. In addition, the durability and friction characteristics of the coating were measured and observed over the course of the evaluation. The anti-icing coating was applied to a 200-foot section of pavement on taxiway Kilo at Chicago O'Hare International Airport. The evaluation was conducted from November 2004 through July 2005.

At the conclusion of the project, a thorough review of all collected data showed that there was no observable improvement between the anti-icing performance of the pavement surfaces with the anti-icing coating and the adjacent pavements that did not have the coating. Additionally, there were signs of delamination and loose aggregate in some areas of the coated test section.

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LIST OF ACRONYMS

AC	Advisory Circular
CFME	Continuous Friction Measuring Equipment
FAA	Federal Aviation Administration
FPD	Freezing-point depressant
KRC	Keweenaw Research Center
NOAA	National Oceanic and Atmospheric Administration
ORD	Chicago O’Hare International Airport
SSI	Surface Sensors Inc.

EXECUTIVE SUMMARY

Airports generally use two common strategies for keeping snow and ice buildup on aircraft movement areas to a minimum. The practice of anti-icing is primarily a preventive, where the formation or development of bonded snow and ice is minimized by timely applications of a chemical freezing-point depressant (FPD) in advance and sometimes during each winter precipitation event. Deicing on the other hand is primarily a reactive practice because the FPD is not applied until snow or ice has already accumulated and formed a bond to the pavement surface. There are advantages and disadvantages to both practices. Anti-icing has the potential of lower costs due to less chemical being used than in deicing; however, a more systematic approach is often needed. Deicing may demand less upfront planning but usually requires a larger quantity of FPD to work its way through the snow pack to reach the snow/pavement interface and destroy or weaken the bond.

Recent advances in pavement texturing processes have indicated a potential to reduce chemical usage on pavements below the amount currently being used. It has been found that certain types of textured aggregates, once sprayed with an FPD chemical, may be able to retain anti-icing characteristics in advance of a winter storm event and even throughout the duration of multiple storm events without reapplication of FPD chemical agents.

The purpose of this study was to evaluate the effectiveness of the anti-icing coating in terms of its anti-icing performance compared to adjacent pavement surfaces that did not have the coating. In addition, the durability and friction characteristics of the coating were measured and observed over the course of the evaluation. The anti-icing coating was applied to a 200-foot section of pavement on taxiway Kilo at Chicago O'Hare International Airport. The evaluation was conducted from September 2004 through July 2005. The evaluation consisted of visual and thermal monitoring, climatic modeling, friction and strength tests, and durability analysis.

At the conclusion of the project, a thorough review of all collected data showed that there was no observable improvement between the anti-icing performance of the pavement surfaces with the anti-icing coating and the adjacent pavements that did not have the coating. Additionally, there were signs of delamination and loose aggregate in some areas of the coated test section. The quantity of FPD required to clear the test bed was the same quantity required to clear other runways and taxiways which did not have the coating.

This report presents the data results of this evaluation, along with visual observations of the test bed throughout the monitoring period. These results will be used by the Federal Aviation Administration to determine merits of the product for use on airport pavements.

1. INTRODUCTION.

1.1 PURPOSE.

The purpose of the project was to observe a pavement test section designed using an anti-icing textured aggregate coating system. The test section was located at Chicago O'Hare International Airport (ORD) at the intersection of taxiway K and taxiway T 11. The objective of the observation was to produce a thorough analysis of the pavement concentrating on durability, surface friction characteristics, and anti-icing performance. These results will be used to determine the merits of using this pavement technology on airport pavements.

1.2 BACKGROUND.

During the winter of 2002, a multi-year-phased research effort was conducted that consisted of a series of tests performed at the Federal Aviation Administration (FAA) William J. Hughes Technical Center, Atlantic City International Airport, NJ and Michigan Technological University Keweenaw Research Center (KRC) on three separate installations of a textured aggregate coating system sprayed with freezing-point depressant (FPD) chemicals. This anti-icing pavement coating technology was evaluated to determine the ability of the treated surfaces to retain anti-icing properties and deicing during a series of storm events and to maintain surface durability under controlled traffic and snow removal operations. Preliminary observations from the initial study phase demonstrated the potential feasibility of the installation process as well as the durability of the coating material under limited winter storm events and controlled traffic conditions. Maintenance friction measurements taken during this phase, using the FAA Saab Friction Tester, also revealed friction characteristics comparable to nontreated adjacent dry pavements.

The research progressed into the second phase that consisted of construction of a larger field observation test section on taxiway K at the intersection of taxiway T 11 at ORD. Construction of the test section was a joint effort between the FAA, KRC, and Chicago O'Hare Airport Authority. The test section, measuring 35 ft wide by 200 ft long, was observed over the course of the 2003 to 2004 winter season under normal airport operations. The test section location is shown in figure 1.

The general construction procedure for the anti-icing pavement overlay is to first place a thin layer of epoxy over the existing pavement surface and then broadcast a layer of absorptive aggregate on the surface of the wet epoxy. As the epoxy hardens, the aggregate is bonded to the surface and provides a resulting surface that looks similar to rough sandpaper. After the epoxy has hardened, a light layer of anti-icing chemical is applied to the surface and allowed to soak into the new surface. The porous nature of the aggregate acts as a sponge to hold the FPD chemical in place and time releases it back to the surface to act as an anti-icing agent.

Once the test section at ORD had been exposed to a full winter season, phase 3, a more comprehensive observation and evaluation study was warranted to evaluate the performance of the system under more controlled circumstances and more frequent data collection. On August 31, 2004, Amendment Number 036 was issued to the Center of Excellence for Airport

Technology for a 12-month study to observe and evaluate the ORD airport pavement test section. This study began on September 1, 2004.

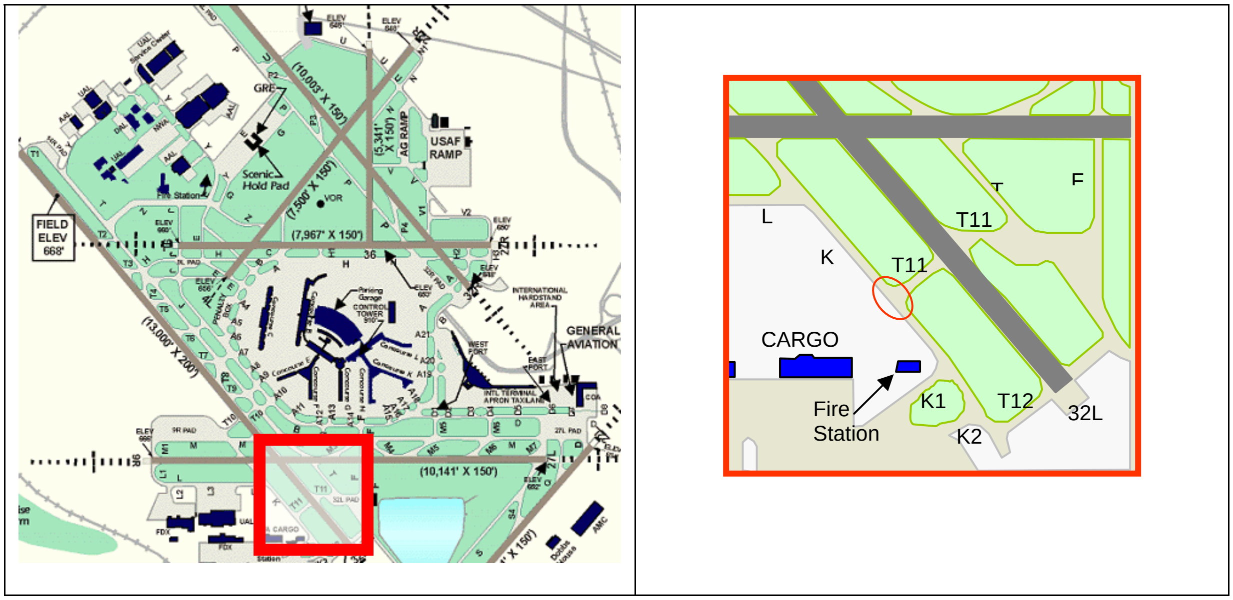

Figure 1. Test Section Location

2. EVALUATION APPROACH.

2.1 EVALUATION METHODS.

To evaluate the performance of the anti-icing pavement overlay, a preliminary plan was developed that concentrated on the three areas of interest: durability, surface-friction characteristics, and anti-icing performance. Different methods were used to evaluate each trait. Those methods are discussed below.

2.1.1 Durability.

Normal snow removal procedures at ORD include the use of displacement and rotary-type plows, as well as broom and brush vehicles. Mechanical snow removal methods of this type require contact between the cleaning apparatus and pavement surface and, therefore, pavement durability is of interest. A durability evaluation was accomplished by monitoring the amount of aggregate loss across the pavement area. In low-traffic areas, a simple qualitative observation of loose aggregate was noted. In high-traffic regions, FAA-approved KJ-Law friction tests were performed. Also, one region that had complete loss of the pavement overlay was monitored throughout the project life cycle. This region was initially documented by measuring the perimeter through radial length measurements sweeping at 10-degree increments. The dimensions were used to recreate the delaminated shape in a drawing program. This drawing was overlaid across a photograph of the region to scale match the perimeter. The initial measurements were compared against a second set of measurements that were taken approximately 3 months later. Regional growth of the area was observed, noted, and is discussed in section 2.2.1.

2.1.2 Surface-Friction Characteristics.

Friction characteristics were monitored using the results of a few friction test runs over the test section. The tests were completed using a model 6850 slip friction tester manufactured by Dynatest Inc. and approved by the FAA for this type of evaluation. Initially, it was believed one test was completed just after installation of the pavement overlay. The data from that friction test was requested, but has not been located. Another friction test was completed on March 27, 2005, to serve as a secondary comparison. To compensate for lack of data, another friction test was completed August 1, 2005, for comparison.

2.1.3 Anti-Icing Performance.

To evaluate the anti-icing and deicing performance of the pavement overlay, visual observations were first collected from on-site visits to the test section. These observations were used to produce a baseline model of the test section. Measurements were taken of the bed perimeter, along with regions that were already delaminating. Digital pictures were also used to record the condition of the test section.

Visual observations were increased on December 10, 2004, with the installation of a 24 hours a day, 7 days a week, surveillance camera system at the site. Figure 2 shows the camera and recording system. The camera system recorded continuously from December 10, 2004, to March 21, 2005, documenting many snow and icing events that occurred throughout the winter season. All anti-icing and/or deicing applications and operations were also documented.

Figure 2. Camera and Recording System

Two disruptions to recording occurred during the life of the project. The first disruption was a power outage that occurred at 10:35 p.m. on January 5, 2005, causing a loss in camera position. The camera was repositioned on the next visit[1] and recording continued. The second interruption occurred near the end of March. It was believed a faulty resistor in the camera caused the camera image to flicker, change color, and black out. This interruption caused little loss of observation, since all major snow and ice events had already occurred.

To evaluate the digital recording, a table of snow and ice events (table 1) was constructed by cross referencing climatic data from the National Oceanic and Atmospheric Association (NOAA) with pavement surface sensor information supplied by Surface Sensors Inc. (SSI). SSI is a company that provides ORD with flush-mounted pavement surface sensors. These sensors provide real-time climatic information to the airport. NOAA data was retrieved via the internet while the SSI data was purchased from the company. SSI data was retrieved from sensors 7 and 8 (figure 3), which are continuous-monitoring sensors that give pavement surface temperature and moisture content. Sensors 7 and 8 are located between 500 and 1000 yards from the test section pavement respectively. Only data from sensor 8 was consistent and accurate; therefore, data from sensor 7 was not used[2].

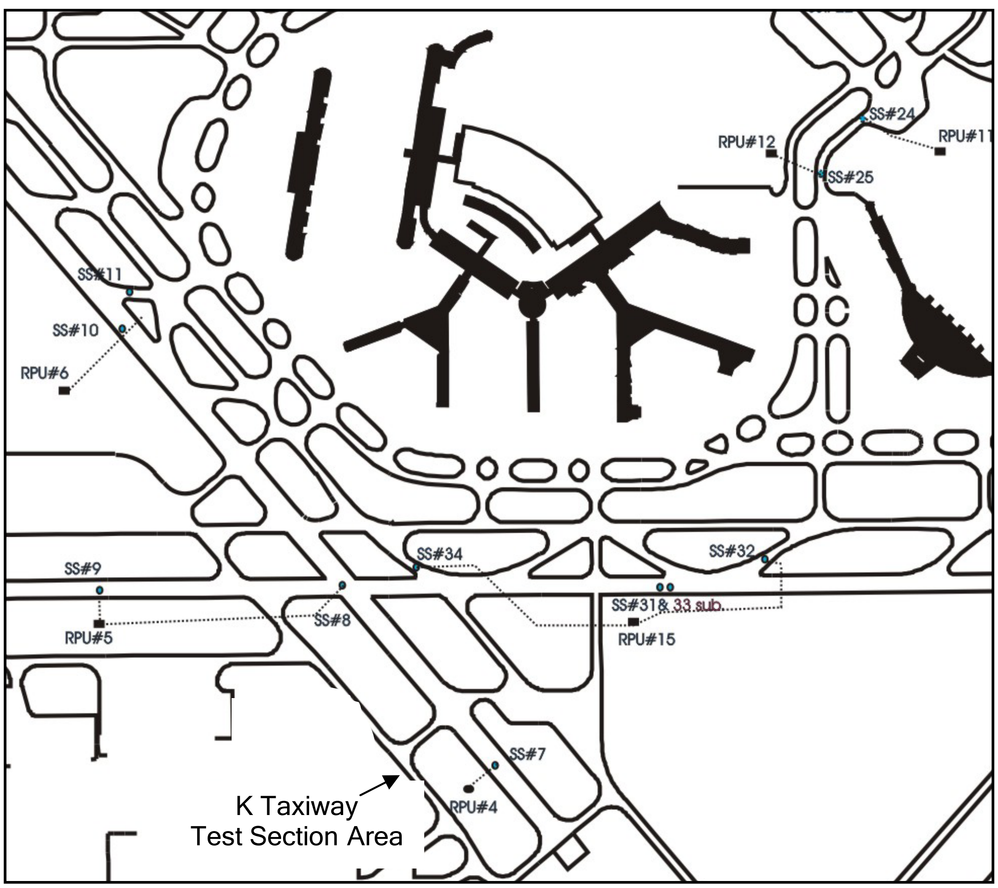

Figure 3. Surface Sensor Map

[1] Monday, January 17, 2005
[2] Sensor 7 registered several “no report” entries compared to sensor 8.

The combined information from NOAA and SSI was used to determine and isolate specific snow and icing events. Each event was reviewed and evaluated to determine the effectiveness of the anti-icing pavement overlay. The individual events were sectioned and documented on an hourly basis to arrive at a basis for determining the effectiveness of the test section with respect to anti-icing. The documented sections were converted to photographs, and organized to show the sequence of events during a snow or icing event. The most useful and best examples are documented in section 2.2.3.

Strict icing events were difficult to isolate from the footage obtained by the camera. The camera's optical zoom capability could not show clear images of just icing, which is even difficult to detect with the naked eye. Also, a lack of light during nighttime recording made it difficult to distinguish ice. Two still images of ice on the test section were taken during on-site visits and are shown in figures 4 and 5. Snow, on the other hand, was very visible and easy to isolate and document. Snow events produced the best still images and were easiest to follow for performance measuring. The best examples of snow events were used in section 2.2.3.

Figure 4. Ice Patches Located on the Test Section, but not on the Adjacent Taxiway, 11/23/04

Figure 5. Ice and Slush Located on the Test Section, but not on the Adjacent Taxiway, 2/23/2005

Table 1. Correlation Table,[3] SSI vs NOAA

SSI No.	SSI Precipitation		NOAA Event No.	NOAA Precipitation Event	
1	11/30/2004 @ 8:00 p.m.	12/1/2004 @ 10:00 a.m.			
1	12/4/2004 @ 9:00 p.m.	12/5/2004 @ 8:20 a.m.			
			1	12/05/2005 @ 10:00 p.m.	12/06/2004 @ 10:00 a.m.
			2	12/07/2004 @ 2:00 a.m.	12/07/2004 @ 4:00 p.m.
			3	12/10/2004 @ 3:00 p.m.	12/10/2004 @ 12:00 a.m.
3	12/18/2004 @ 7:50 p.m.	12/19/2004 @ 12:50 a.m.	4	12/18/2004 @ 2:00 p.m.	12/19/2004 @ 5:00 a.m.
4	12/21/2004 @ 2:40 a.m.	12/21/2004 @ 9:00 a.m.			
5	12/21/2004 @ 2:40 a.m.	12/26/2004 @ 8:10 a.m.	5	12/25/2004 @ 6:00 a.m.	12/26/2004 @ 1:00 a.m.
6	12/28/2004 @ 9:10 p.m.	12/29/2004 @ 9:20 a.m.			
7	12/29/2004 @ 5:20 p.m.	12/29/2004 @ 10:20 p.m.			
8	12/30/2004 @ 1:10 a.m.	12/30/2004 @ 6:50 a.m.	6	12/30/2004 @ 9:00 a.m.	12/30/2004 @ 11:00 p.m.
			7	1/1/2005 @ 7:00 p.m.	1/2/2005 @ 8:00 a.m.
			8	1/3/2005 @ 2:00 a.m.	1/3/2005 @ 10:00 p.m.
9	1/4/2005 @ 9:20 p.m.	1/8/2005 @ 12:00 p.m.	9	1/4/2005 @ 8:00 p.m.	1/6/2005 @ 1:00 p.m.
10	1/8/2005 @ 3:30 p.m.	1/9/2005 @ 10:00 a.m.			
11	1/10/2005 @ 12:40 a.m.	1/10/2005 @ 8:10 a.m.			
12	1/19/2005 @ 4:50 a.m.	1/19/2005 @ 12:10 p.m.	10	1/18/2005 @ 8:00 p.m.	
13	1/20/2005 @ 6:00 a.m.	1/21/2005 @ 10:50 a.m.			
14	1/21/2005 @ 6:30 a.m.	1/23/2005 @ 10:50 a.m.			1/23/2005 @ 12:00 p.m.
15	1/23/2005 @ 3:40 p.m.	1/24/2005 @ 9:50 a.m.			
16	1/24/2005 @ 6:00 p.m.	1/25/2005 @ 8:40 a.m.			
17					
18	1/26/2005 @ 4:00 a.m.	1/26/2005 @ 7:00 a.m.			
19	1/262005 @ 3:30 p.m.	1/272005 @ 2:10 p.m.		1/27/2005 @ 1:00 a.m.	1/27/2005 @ 11:00 p.m.

Note: Shaded areas represent correlated events.

2.1.4 Schedule of Visits.

The site of the test section was visited seven times during the monitoring period. During each visit, the test section was observed and all changes to the test section were noted. Many visits were also used to retrieve information from the airport staff and gain insight through conversation with the ORD operations department. A comprehensive log of each visit is shown in table 2.

[3] Times in the table represent the time at which the sensor began to show the presence of snow or ice.

Table 2. Schedule of Visits

Date of Visit	Purpose
10/6/2004	Took baseline measurements of test section Took photographs of entire test section Briefed on airport snow removal operations Met with airport personnel relevant to project
11/12/2004	Took measurements of test section Took photographs of entire test section Delivered camera and recording equipment to site for installation Met with network department and contractors to discuss installation Took two pavement core samples
12/10/2004	Took measurements of test section Took photographs of entire test section Took baseline measurement of delaminated region Set up camera and recording equipment Began recording
1/19/2005	Took measurements of test section Took photographs of entire test section Repositioned camera from power outage Continued recording
2/11/2005	Took measurements of test section Took photographs of entire test section Retrieved information from the log books of operations department Placed new hard drive into recording system Repositioned camera Continued recording
3/24/2005	Took measurements of test section Took photographs of entire test section Took final measurement of delaminated region for comparison Noted camera repairs needed (blown resistor near lens) Requested new friction test Met with KRC and FAA
6/17/2005	Received blueprints of test section region Picked up final hard drive for review

2.2 EVALUATION OF RESULTS.

2.2.1 Durability.

During each visit to the test site, loose aggregate was observed. The aggregate was noticed across the entire test section, with the largest quantity accumulating at the shoulders. These areas of large accumulation were probably created from aircraft engines blowing the debris to the edges of the pavement. Aggregate was missing in small amounts from many regions of the test section, but was absent in larger quantities near the joints of the underlying pavement. An example of missing aggregate near a joint is shown in figure 6. Also, note the oval patch with significant aggregate loss.

Figure 6. Aggregate Loss at the Test Section Pavement Joint

Along with small amounts of aggregate loss, major delamination occurred at one region of the overlay. The area was documented and observed throughout the life of the project. The region was located at the intersection of multiple-traffic paths. All southeast- and northwest-bound aircraft had one set of wheels impact the area. It was also observed that the area was a pivot point for some aircraft while turning to enter or leave the runway via taxiway T 11. The last traffic path was from small emergency vehicles entering taxiway K after leaving the adjacent rescue station. A schematic of traffic flow for the area is shown in figure 7.

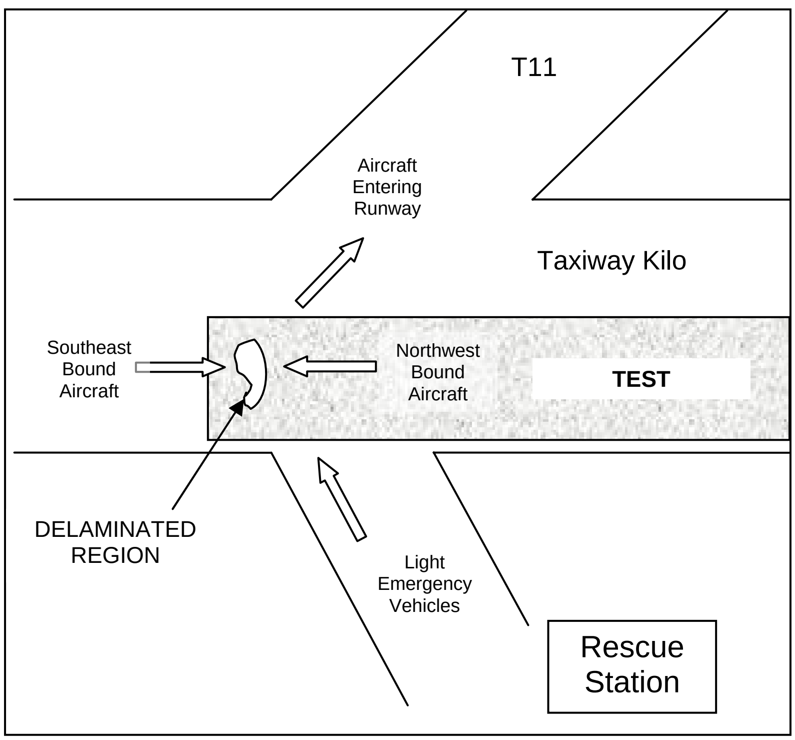

Figure 7. Traffic Flow Diagram of the Test Section Region

Examples of traffic activities are shown in figures 8 through 11. As shown in figure 8, emergency vehicles often passed over the delaminated region. These vehicles commonly turned off of Taxiway K via the road in the foreground. Figure 9 shows a northwest-bound aircraft. It can be seen that the rear dual wheel will cross directly over the delaminated region. Figure 10 shows a southeast-bound aircraft whose rear right dual-tandem wheel is almost over the delaminated area. Figure 11 shows an aircraft that has just turned onto the taxiway and shows that the belly dual-tandem wheel is still pivoting as it approaches the delaminated region.

Figure 8. Emergency Vehicle on the Test Section

Figure 9. Northwest-Bound Aircraft on the Test Section

Figure 10. Southeast-Bound Aircraft on the Test Section

Figure 11. Aircraft Turning Onto the Test Section

The delaminated region shown in figure 7 and pictured in figure 12 was monitored throughout the observation cycle. Initial radial measurements of the region were taken on December 10, 2004, and used to develop an approximation of the missing area. These measurements served as a baseline measurement of the region. The same radial measurements were taken approximately 3 months later on March 24, 2005, to establish the approximate rate of growth. Table 3 shows the change in radial dimensions over the 3-month period.

Figure 12. Delaminated Region of the Test Section

Table 3. Radial Length Dimensions for Durability Analysis

Radial Angle (degrees)	Initial Radius Dec. 10, 2004 (in.)	Final Radius Mar. 24, 2005 (in.)	Change in Length (in.)
0	11.5	11.5	0
10	31	35	4
20	39	41.5	2.5
30	42	44	2
40	45.5	47	1.5
50	50	51.5	1.5
60	52.5	53.5	1
70	54	54.5	0.5
80	56.5	57	0.5
90	57.5	58	0.5
100	60	60	0
110	34	34	0
120	22	23	1
130	17	17	0
140	13	17	4
150	11.5	15	3.5
160	11.5	14	2.5
170	12	12	0
180	12	13	1
190	13	13	0
200	13	13	0
210	14	14	0
220	13	13	0
230	16	16	0
240	21	21	0
250	28	29.5	1.5
260	37	41	4
270	52.5	52.5	0
280	55	56	1
290	46	47	1
300	11.5	11.5	0
310	11.5	11.5	0
320	11.25	11.25	0
330	11.25	11.75	0.5
340	11.75	12	0.25
350	11.75	12	0.25
360	11.75	12	0.25

2.2.2 Surface-Friction Characteristics.

The FAA establishes the need for conducting periodic evaluation of pavement surfaces as:

> "Over time, the skid-resistance of runway pavement deteriorates due to a number of factors, the primary ones being mechanical wear and polishing action from aircraft tires rolling or braking on the pavement and the accumulation of contaminants, chiefly rubber, on the pavement surface…Other influences in the rate of deterioration are local weather conditions, the type of pavement (HMA or PCC), the materials used in the original construction, any subsequent surface treatment, and airport maintenance practices." (FAA Advisory Circular (AC) 150/5320-12C Measurement, Construction, and Maintenance of Skid-Resistant Airport Pavement Surfaces, Chapter 3, 1997.)

Surface-friction characteristics were analyzed by comparing data from two Continuous Friction Measuring Equipment (CFME) friction tests approved by the FAA for maintenance-level measurement. The tests were conducted using standard practices for conducting maintenance assessments using CFME on the airport, i.e., 40 mph, using the onboard self-wetting system. It should be emphasized that these measurements were taken to ascertain whether any significant degradation of the pavement surface friction had taken place during the evaluation period. These measurements were not intended to provide a measure of the surface friction while winter contaminants were present on the surface. The first measurements were taken on March 27, 2005, and the second measurements were completed on August 1, 2005. The data from the March 2005 friction test indicated an average friction coefficient of 0.80 for the measured test bed surface. The August 1, 2005, friction test data indicated an average friction coefficient of 0.735. Based on these limited data, the test pavement exhibited an average drop in the friction coefficient of 0.065, which for the purposes of this study, will not be considered to be significant. According to 150/5320-12C, "Measurement, Construction, and Maintenance of Skid-Resistant Airport Pavement Surfaces," the friction levels measured on the test surface during this evaluation indicate that the pavement is essentially at or near the classification of New Design/Construction pavement.

2.2.3 Anti-Icing Performance.

Anti-icing and deicing properties were evaluated by reviewing the snow and ice events captured on film and the snow removal records provided by the operations department at ORD. Throughout the observation life of the project, approximately seven major events were recorded along with eight to ten smaller events. The seven major events were reviewed and documented with the greatest detail. The documentation of the events was as followed.

1. Isolate beginning of event
2. Isolate previous deicing agent application
3. Document time of application
4. Monitor hourly activity of test pavement
5. Document following deicing activities

6. Document all snow removal activities (brushes, plows, etc.)
7. Determine performance of anti-icing overlay

The three most significant and best-documented snowfall events are reviewed in this section. The photographs represent the timeline of each snow or ice event. Although FPD chemicals are applied based on pavement temperatures, air temperature was used at the time each photograph was taken. The temperatures listed in the figure captions represent air temperature and pavement temperature respectively. Qualitative terms are also listed in the figure captions. These terms were set by University of Illinois researchers assigned to the project and generally represent quantitative equivalents of Light = 1 to 2 in.; Moderate = 2 to 5 in.; and Heavy = 5 or more in.

Figure 13 shows the general outline and location of the test section. The black rectangular sign in the background can be used as a reference point in the following figures.

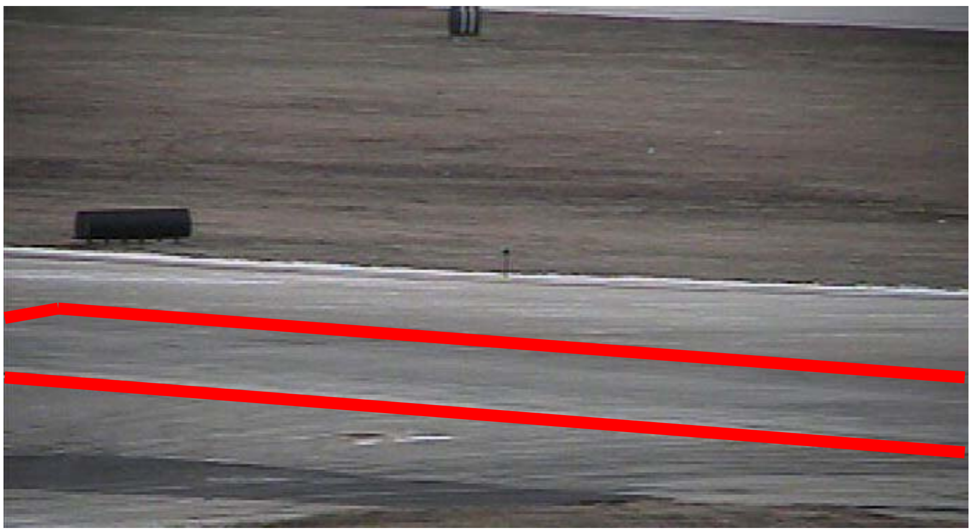

Figure 13. Outline of the Test Section

2.2.3.1 Event 12/25/2004.

The event documented in figures 14 through 25 represent the first major snow event for the 2004/2005 winter season. The event officially began at approximately 5:00 p.m. on December 25, 2004, with heavy snowfall. The snowfall tapered off by 1:00 a.m. on December 26, 2004. The figures show that FPD chemicals were applied to the test section about 7 hours prior to the snow event (figure 14). Upon arrival of the storm event, the taxiway was quickly covered and remained snow covered for approximately 9 hours before being cleaned and brushed by the operations team. By this time, the snowfall had diminished and the taxiway remained clear. FPD anti-icing chemicals were again applied at 6:35 a.m. on December 26, 2004, as a precautionary measure to the possibility of more snow and/or ice. In total, this snow event produced a water equivalent of 0.20 inch.

Figure 14. Deicing Agent Applied 12/25/04, 9:38 a.m., 12°/19.4°F

Figure 15. Pavement Clear 12/25/04, 4:00 p.m., 18°/22.3°F

Figure 16. Heavy Snowfall, Pavement Nearly Covered, 12/25/04, 5:00 p.m., 19°/20.8°F

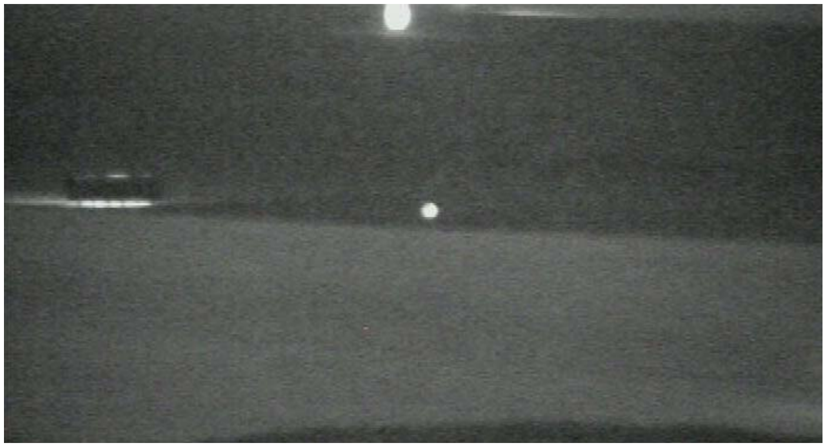

Figure 17. Heavy Snowfall, Pavement Nearly Covered, 12/25/04, 7:00 p.m., 19°/20.7°F

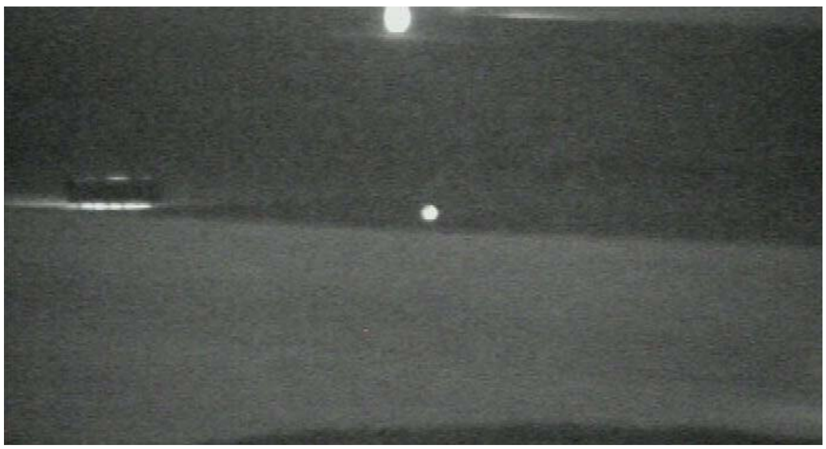

Figure 18. Moderate Snowfall, Pavement Covered, 12/25/04, 9:00 p.m., 19°/21.0°F

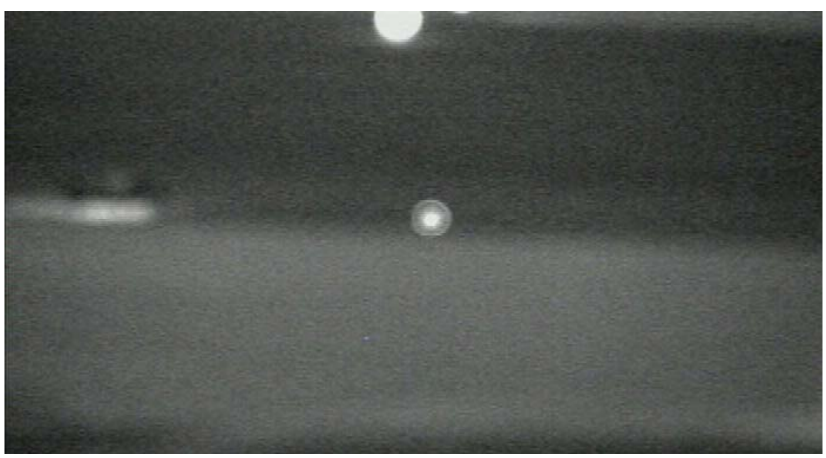

Figure 19. Light Snowfall, Pavement Covered, 12/25/04, 11:00 p.m., 19°/20.8°F

Figure 20. Light Snowfall, Pavement Covered, 12/26/04, 1:00 a.m., 19°/19.4°F

Figure 21. No Snowfall, Pavement Plowed and Brushed, 12/26/04, 2:14 a.m., 19°/19.2°F

Figure 22. No Snowfall, Pavement Clear, 12/26/04, 3:00 a.m., 19°/20.1°F

Figure 23. No Snowfall, Pavement Clear, 12/26/04, 4:00 a.m., 18°/19.6°F

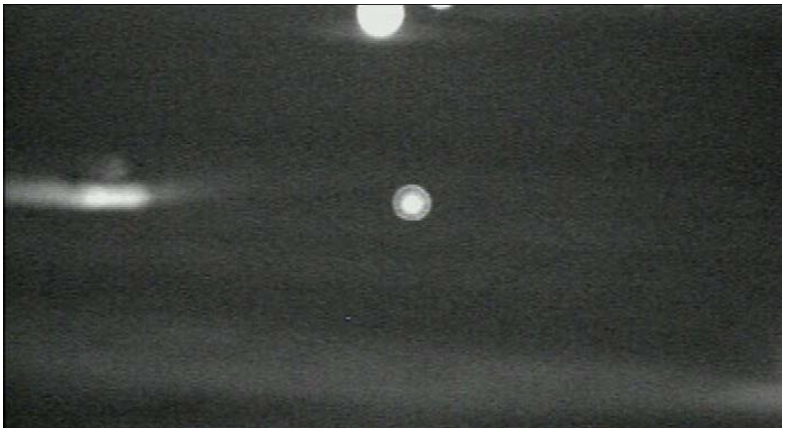

Figure 24. No Snowfall, Pavement Clear, 12/26/04, 6:00 a.m., 16°/15.6°F

Figure 25. Deicing Agent Applied, Pavement Clear, 12/26/04, 6:35 a.m., 16°/14.7°F

2.2.3.2 Event 01/03/2005.

The event documented in figures 26 through 37 represents the second largest snow event observed during the winter season. It officially began at approximately 10:00 p.m. on January 4, 2005, but as can be seen in figures, the first FPD chemical application for this event occurred at 4:40 a.m. on January 3, 2005. This was almost 40 hours before the snowfall event took place. FPD chemicals were also applied 1 hour before the snow began to fall. Initially, light snow fell just dusting the test section, but moderate amounts came by midnight and completely covered the entire region. The test section was plowed and brushed at about 4:00 a.m., on January 5, 2005, but quickly began to accumulate more snow. By 7:00 a.m., the taxiway was covered once again and remained covered for more than 12 hours. Taxiway K remained covered until it was brushed and deiced at 7:22 p.m. on January 5, 2005.

Air temperatures hovered around the freezing point for the majority of the event, and it was expected that the FPD chemicals applied to the test section would be very effective at those temperatures. In total, this snow event produced a water equivalent of 0.46 inch.

Figure 26. Deicing Agent Applied, 1/3/05, 4:40 a.m., 33°/35.6°F

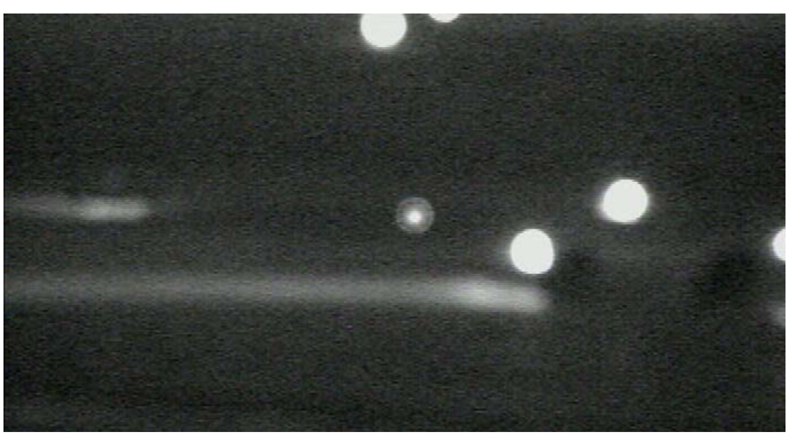

Figure 27. Deicing Agent Applied Again, No Snowfall, 1/4/05, 9:03 p.m., 30°/32.2°F

Figure 28. Light Snowfall, Snow Beginning to Stick, 1/4/05, 10:00 p.m., 33°/32.2°F

Figure 29. Light Snowfall, Little Change, 1/5/05, 12:00 a.m., 31°/32.0°F

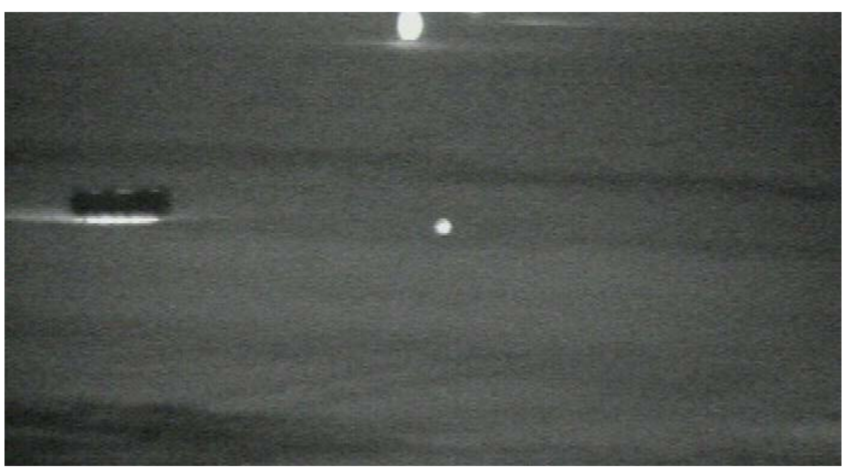

Figure 30. Moderate Snowfall, Pavement Covered, 1/5/05, 2:00 a.m., 30°/29.3°F

Figure 31. Light Snowfall, Pavement Plowed and Brushed, 1/5/05, 3:55 a.m., 30°/30.2°F

Figure 32. Light Snowfall, Pavement Relatively Clear, 1/5/05, 4:00 a.m., 30°/30.2°F

Figure 33. Light Snowfall, Snow Starting to Stick, 1/5/05, 6:00 a.m., 29°/27.1°F

Figure 34. Moderate Snowfall, Pavement Again Covered, 1/5/05, 8:00 a.m., 29°/29.7°F

Figure 35. Moderate Snowfall, Pavement Covered, 1/5/05, 10:00 a.m., 28°/30.4°F

Figure 36. Light Snowfall, Pavement Covered, 1/5/05, 12:00 p.m., 27°/31.1°F

Figure 37. Moderate Snowfall, Pavement Covered, 1/5/05, 2:00 p.m., 27°/30.4°F

2.2.3.3 Event 01/21/2005.

The event documented in figures 38 through 49 represents the last and largest major snow event captured by the camera system. Other events were viewed, but none with such significance. This event began at about 6:00 p.m. on January 21, 2005. By 8:00 p.m., the taxiway was completely covered. Just after 10:00 p.m., the area was plowed and brushed, clearing the taxiway for only a few minutes. By 1:00 a.m. on January 22, 2005, the pavement was completely covered and remained covered until 5:35 a.m. when it was once again cleared by plow and brush. By 6:00 a.m., the pavement was once again covered and remained covered for another 14 hours, until it was again brushed and deiced at 8:00 p.m. It is interesting to note that deicing agent was applied three separate times during the 40 hours leading up to the event. In total, this snow event produced a water equivalent of 0.72 inch.

Figure 38. Deicing Agent Applied, 1/20/05, 3:18 a.m., 24°/26.1°F

Figure 39. Deicing Agent Applied Again, 1/20/05, 4:49 p.m., 26°/27.7°F

Figure 40. Deicing Agent Applied Again, 1/21/05, 12:39 a.m., 24°/24.3°F

Figure 41. Light Snowfall, Pavement Clear, 1/21/05, 6:00 p.m., 20°/26.2°F

Figure 42. Moderate Snowfall, Pavement Covered, 1/21/05, 8:00 p.m., 19°/25.2°F

Figure 43. Moderate Snowfall, Pavement Plowed and Brushed, 1/21/05, 10:10 p.m., 19°/24.6°F

Figure 44. Moderate Snowfall, Pavement Covered, 1/22/05, 1:00 a.m., 18°/26.2°F

Figure 45. Moderate Snowfall, Pavement Covered, 1/22/05, 4:00 a.m. 17°/27.1°F

Figure 46. Moderate Snowfall, Plowed and Brushed, 1/22/05, 5:35 a.m., 17°/25.7°F

Figure 47. Light Snowfall, Pavement Covered, 1/22/05, 6:00 a.m., 17°/24.6°F

Figure 48. Light Snowfall, Pavement Covered, 1/22/05, 7:00 a.m., 17°/23.2°F

Figure 49. No Snowfall, Pavement Covered, 1/22/05, 12:00 p.m., 21°/27.1°F

3. SUMMARY.

3.1 GENERAL.

A pavement test section treated with an absorbent textured aggregate system sprayed with an anti-icing FPD chemical agent was observed for an extended period throughout the winter season of 2004/2005 at Chicago O'Hare International Airport . The observation produced an analysis of the pavement concentrating on durability, surface-friction characteristics, and anti-icing performance to determine the merits of using this pavement technology on airport pavements. Observations made during this study indicated that the approach has some problems.

3.2 DURABILITY.

The presence of loose aggregate on the test section indicated that the epoxy was not holding all the aggregate in place. The majority of the loose aggregate seemed to come from areas that were laid near the joints in the pavement. At these points, considerable amounts of the aggregate were missing, exposing the underlying pavement. Close inspection of the test section revealed that aggregate was also missing in small amounts across the entire area.

Some loose aggregate could also be coming from the large delaminated region. Radial measurements taken of one such delaminated area indicated that the region is slowly continuing to delaminate. Some of the radial dimensions changed as much as 4 inches in length over a 3-month period.

It is unknown at this time why this area delaminated, but a few observations may provide some insight into the cause(s). First, information was provided stating the area was a problem point during and just after overlay construction. The aggregate and epoxy would not adhere as well in this area and, therefore, the area had to be repaired. Second, it was noted that this area is located at a point of considerable traffic. The area is impacted from every direction by aircraft and emergency vehicles. It was also observed that the wheels of aircraft leaving and entering taxiway K and the test section pivoted on the region while the aircraft turned toward or away from the runway. It is speculated that the large shear force caused by a pivoting wheel caused this delamination.

3.3 SURFACE-FRICTION CHARACTERISTICS.

The March 27, 2005, friction test indicated an average friction coefficient of 0.80 while the August 1, 2005, friction test produced an average friction coefficient of 0.735. As shown from surface-friction test data, the friction coefficient dropped by 0.065 over a period of 128 days. While this represents a significant drop in the friction characteristics of the pavement, the pavement is still considered to be above maintenance levels according to AC 150/5320-12C, "Measurement, Construction, and Maintenance of Skid-Resistant Airport Pavement Surfaces," Chapter 3, 1997.

This drop in the friction coefficient was most likely caused from excessive wear across the test section. Observed types of wear that could cause such a drop in the friction coefficient were aggregate loss exposing only the adhesive agent, loose aggregates still partially embedded, and rounding of aggregates at the surface. The drop of 0.065 in the friction coefficient most likely occurred from a combination of the wearing behaviors listed and snow-clearing operations.

3.4 ANTI-ICING PERFORMANCE.

After a thorough review of all the recorded video images, there was no indication that the test section behaved any differently than the surrounding noncoated pavement. Review of storm sequences showed the application of the test section with FPD chemical agent prior to a storm activity. During a storm event, snow stuck and began to accumulate on the test section and adjacent pavements in equal amounts. These regions remained snow covered until the operation department plowed and brushed the areas. Subsequent applications of the FPD chemical agent kept both the test section and adjacent pavement clear for a few hours, but accumulation again occurred to both pavements at the same rate. There was no indication in the video images that the anti-icing overlay performed any differently or better than the noncoated pavement areas of the taxiway.

The observations made during the course of this experiment indicate that the anti-icing coating does not offer a significant advantage or benefit over the adjacent pavements that were not treated with the coating.