Project Title: AIRFIELD MARKING DURABILITY STUDY

Date: 12 March 2014

Organization: Potters Industries, Inc.

Project Location: Malverne, PA

Sightline, LC
Airport Marking Consultants
15483 Enterprise Way
Culpeper, VA 22701

540-825-9660

540-825-9088 (FAX)

DONNA J. SPEIDEL – 540-226-2656 (CELL)
donna@sightline.us

MICHAEL W. SPEIDEL – 540-272-3583 (CELL)
mike@sightline.us

http://www.sightline.us/
EXECUTIVE SUMMARY

Pavement markings on airfields provide guidance to pilots and others operating on airfield surfaces. Airfield pavement markings are enhanced when installed with glass beads embedded in the coating. When properly applied according to the Airfield Marking Handbook\(^1\), the use of glass beads provides greater conspicuity through reflectivity. Airfield marking reflectivity increases pilot preview time and distance recognition at night and low light conditions, which improves user situational awareness and safety.

Low-index glass beads, Federal Specification TT-B-1325D Type I, are less expensive than high-index glass beads, TT-B-1325D, Type III. Despite the higher initial cost, Type III beads have superior retro-reflectivity performance and a longer life cycle.

Sightline performed the study documented in this report to determine if the use of high-index Type III glass beads would result in airfield markings that (1) remained effective longer, (2) reduced the frequency of maintenance, and (3) reduced the cost of marking maintenance. Based on reflectivity data recorded at 13 airports across the United States, including military and commercial, Type III glass beads provide higher levels of retro-reflectivity initially and over time, resulting in lower maintenance costs.

---

1.1 Introduction

Pavement markings provide guidance to pilots and others operating on airfield surfaces. The markings must be clearly visible during both daylight and darkness, “ensuring that each [marking] provides an accurate reference to the user.”

Paint markings deteriorate gradually in terms of and markings are maintained with regular frequency; often annually. When markings are properly installed using best practices, the frequency of maintenance can be decreased because the markings remain effective (visible) longer. Best practices include the use of high-quality materials suitable for the airport’s environment resulting in effective markings that last multiple years.

The type of glass bead applied has a significant role in how long the markings can remain effective during darkness. There are two families of glass beads approved for use on airfields, commonly classified as “low index” and “high index”. High index glass beads (e.g. FAA TT-B-1952D, Type III) reflect more light back to its source than low index glass beads (e.g. FAA TT-B-1952D, Types I and IV). Type III glass beads not only last longer, but have higher retro-reflectivity, are brighter in appearance, and provide greater distance recognition, contributing to higher user situational awareness, visible in Figure 1.

![Figure 1 – Type III beads on arrow heads measured 1100 mcd/m2/lx, Type I on arrow stems measured 350 mcd/m2/lx.]

Markings are maintained or repainted when they no longer can be seen clearly. The brightness of pavement markings is measured in millicandela per square meter per lux (mcd/m2/lx). Department of Defense (DoD) specifications require newly installed white markings to have a minimum reflective level of 200 mcd/m2/lx and 175 mcd/m2/lx for yellow markings. By comparison, a white marking without any glass beads measures 50 mcd/m2/lx. A study conducted by the Federal Aviation Administration’s Technical Center at Atlantic City concluded that a retro-reflectivity value of 100 mcd/m2/lx for white markings and 70 mcd/m2/lx for

---

2 Part 139 of the Code of Federal Regulations (CFR) 49, Subsection 311(d)
3 Unified Guide Specification 32 17 23.00, Section 3.2.2.1. – Reflective Markings, p. 19, April 2006.
yellow markings was the lowest acceptable level of reflectivity. Markings below that level are ineffective and require maintenance.

Studies conducted by the Transportation Research Board and other agencies have concluded that “minimum retro-reflectivity values are speed dependent. Preview distance is important, especially at higher speeds [that occur during landings and take-offs of aircraft]. When drivers [or pilots] are provided with higher reflectivity values, longer preview distances are achieved, which is desirable from an information acquisition, information processing, and safety point of view.”

Several studies conducted over the last decade conclude “Type III beads are brighter and more visible than Type I at installation.” Those studies also indicated that “the Type III markings remain brighter longer,” and consequently require less maintenance relative to maintaining retro-reflectivity.

1.2 Objective
Following were the main objectives were of the study:

2. Evaluate markings from commercial and military airfields that were at least two years old.
3. Compare retro-reflectivity measurements of different types of glass beads relative to the age of both white and yellow markings.

The research team had difficulty finding airport markings with Type I beads that were more than two or three years old. Two airports that used Type III beads had markings that were over seven years old.

---

1.3 Evaluation

Airports were identified where markings (using either Type I or Type III glass beads) were applied and/or maintained one or more years prior.

Once identified, technicians traveled to each airport to gather retro-reflectivity readings. Airports were selected in different geographic and environmental regions within the continental United States so that all weather conditions, including snowplow activity, would be represented.

The markings at airports that used Type I glass beads averaged two years of life for the markings; markings at airport that used Type III glass beads averaged four years life. Figure 2 is a compilation of the data collected from thirteen airports throughout the United States.

The data demonstrates that retro-reflectivity measurements of white and yellow markings applied with Type III beads achieve higher readings initially and over multiple years. The data also shows markings applied with Type III have a longer effective life cycle.

1.4 Other Research Data

Historical research involving the collection of airfield marking retro-reflectivity data supports the results of this study. The study referenced in Figure 3 compared a polymer concrete marking material (Permastripe™) to waterborne paint; and both Type I and Type III glass beads were used.  

---

Another study concluded that the “Type III (1.9 IOR) Airport bead had the highest retro-reflectivity initially and over time.”

1.5 Cost Comparison

To illustrate the cost benefit of Type III beads, one of the subject airports, NAS Fort Worth, was selected for a cost comparison. Two estimates were computed theoretically to hire a contractor to repaint the airfield markings, first using Type I beads, and second using Type III beads. As seen in Figure 4, the estimate for Type I beads was $272,832; and in Figure 5, the estimate for Type III beads was $335,885.

---

The graph seen in Figure 6 illustrates the relative cost of Type I beads applied at NAS Fort Worth over an eight-year period versus the cost of Type III beads applied over the same time line. At approximately 1-1/4 years, the cost of each type is even, and Type III glass beads are more cost effective thereafter with a higher return on investment.
Besides the cost effectiveness of fewer airfield painting cycles, lowering the number of paint layers applied diminishes the likelihood markings can become foreign object debris (FOD) (Figure 7), and reduces paint removal costs over time. After five marking cycles or an accumulation of 40 mils of paint, the markings may need to be removed.  

10 UFGS 32 17 23.00, Part 3, Section 3.1 – Surface Preparation:
“Existing marking paints with paint build-up greater than 1 mm 40 mils shall be completely removed in accordance with Section 32 01 11.51, unless crack free and determined sound. When tested for adhesion (ASTM D4541), a sound marking paint must exhibit greater than 0.97 MPa 140 psi adhesion and/or produce 100 percent cohesive failures within the pavement.”

Figure 6 – Cost comparison of Type I and Type III glass beads over eight years.

Figure 7 – Each maintenance cycle results in another layer of paint and glass beads. Paint build up has been related to foreign object debris (FOD).
1.6 Conclusions

Type III glass beads are brighter initially and over time when applied well.

The additional cost of Type III glass beads can be justified by the longer, sustained performance versus Type I glass beads. Over time the cost of using Type I glass beads exceeds that of Type III due to the greater frequency of painting required to maintain visibility. Further, when markings are maintained less frequently, as with Type III beads, layers of paint build up are minimized, reducing the chance for FOD and delaying the need for paint removal.

Type III glass beads provide brighter, longer lasting markings on airfields, increasing situational awareness, safety, and cost effectiveness.