GARMIN INTERNATIONAL EXPANSION REQUIRES SPECIAL FLOORING

BY ERIK VAN ANGLEN

Garmin International is a world leader in GPS technology. Founded in 1989, Garmin manufactures GPS-based technology for applications ranging from space travel and aviation and automotive and wireless applications to fishermen and outdoor enthusiasts. Because so many applications depend on the accuracy and dependability of the electronic components, great attention is paid to building and maintaining an environment where the devices can be manufactured and assembled with the least risk of damage from electrostatic discharge.

ESD is a common problem in electronics manufacturing facilities. Excessive ESD events can cause component failures that are classified as either catastrophic or latent. Catastrophic failures are immediately evident and discovered in the normal course of quality control. Latent failures are not discovered during quality control testing; they happen after the product is in the consumer's hands. While both modes of ESD failures are costly, latent failures not only damage the bottom line but would also affect the consumer's confidence in Garmin. Garmin has adopted the industry standard for ESD control programs: ANSI ESD S20.20, For the Development of an Electrostatic Discharge Control Program for Protection of Electrical and Electronic Parts, Assemblies and Equipment.

All ESD control ultimately depends on a low-resistance path to ground to eliminate differences in electrical potential between personnel, work surfaces, and equipment. Typical control measures include conductive wrist straps for personnel, static dissipative work surfaces, and ionizers. Because the floor is the largest work surface in the manufacturing arena, it provides a very effective means for electrostatic control on personnel. By applying a static dissipative coating to the floor, personnel wearing static dissipative shoes or conductive heel straps are effectively grounded while walking across the floor. In addition, carts and other furniture are also effectively grounded when in contact with the ESD floor surface.

PROBLEMS THAT PROMPTED THE REPAIR

Garmin continuously expands their manufacturing facility in Olathe, KS, as the company grows. Areas once used as warehousing are converted to manufacturing to keep up with the demand for GPS units. During a recent 11,000 ft^2 (1022 m^2) expansion in September 2009, consideration was given to ESD flooring for an assembly area. While there are several options for ESD flooring, Garmin chose an epoxy thin-film ESD system due to its ability to withstand point loads, fast installation, and turnaround time, as well as aesthetics.

During the initial examination phase of the project, moisture testing was performed on the concrete substrate and found to be in excess of the recommended level for application of impervious coatings. Excessive moisture is a well-known failure mechanism for resinous flooring. Disbondment occurs as a result of moisture condensing at

Garmin headquarters, Olathe, KS

the bond line between the concrete substrate and the coating. To protect their investment in the ESD resinous floor system, Garmin investigated their options to ensure the abnormally high moisture content would not lead to premature failure. In addition to the premium value of the ESD coating, Garmin also considered the possible costs of a coating failure in terms of lost production and process interruption.

INSPECTION

During the initial evaluation of the floor surface, moisture readings were obtained by ASTM F2170, "Standard Test Method for Determining Relative Humidity in Concrete Floor Slabs Using in situ Probes." This method of testing for excessive moisture in the concrete prior to coating involves drilling 5/8 in. (15.9 mm) holes in the slab and inserting a humidity-sensitive probe. The relative humidity (RH) within the conditioned hole is measured with a meter. In-place RH testing was chosen, as it offers a method that is both accurate and repeatable. Traditional calcium chloride testing is often inaccurate and easily skewed by the ambient conditions. The results of this testing indicated an average RH reading of 91.7%. The decision was made by consensus between the owner, the general contractor, and the manufacturer to install a surface-applied moisture barrier prior to installing the final floor finish.

REPAIR SYSTEM SELECTED

The material chosen for the surface-applied water vapor barrier was a three-component, solvent-free, odorless, moisture-insensitive, epoxy-modified, cementitious self-leveling mortar. The product is self-leveling and provides an ultimate compressive strength of 9400 psi (64.8 MPa). In addition, the material is odorless, allowing application with an occupied work area immediately adjacent to the construction.

The ESD coating system is comprised of an electrically conductive high-solids primer. The conductive primer provides a continuous electrical ground plane for the subsequent ESD epoxy coating.

The ESD epoxy finish coat is a 100% solids, low-odor, two-component epoxy system with

Garmin's ESD floor after completion of installation

Garmin's ESD floor after completion of installation

integral conductive polymer dispersion and is electrically reactive throughout the thickness of the coating.

SITE PREPARATION

Before application, the floor was prepared using recirculating steel shot blasting to achieve a surface profile of ICRI CSP 3 minimum. Because the cementitious overlayment was applied at approximately 110 mils (2.8 mm), the actual surface profile was ICRI CSP 4. Portable shot-blasting equipment provides the speed and efficiency needed, as well as virtually dust-free operation. Dust prevention was a critical factor in preparation methods and equipment. An active manufacturing area was immediately adjacent to the construction area. Margins and edges were prepared by diamond-abrasive grinding.

Because the application was being performed in a space where the permanent heat had yet to be installed and the outside temperatures had begun to fall, supplemental heat was provided by the general contractor to bring the surface temperature to the manufacturer's recommended level. This ensured the cementitious resurfacer and the epoxy-coating system would perform as expected during application.

SYSTEM INSTALLATION

The water-vapor-resistant cementitious topping was applied by screed rake, finished with a "porcupine"-type roller. The screed rake ensures a uniform application thickness of 110 mils (2.8 mm) and the spiked roller allows for air release and leveling of the slurry. The overlayment material was allowed to cure for the prescribed period. The overlayment material was capable of receiving the finish topcoats after 1 day of cure at 70°F (21°C). After curing, the overlayment was prepared by sanding to produce the required ICRI CSP 3 finish.

Prior to application of the epoxy ESD primer and coating, the material was tested using a surface impedance moisture meter. The cementitious overlayment required a moisture content of 4% or less before over-coating with an epoxy material. Typically, this level is reached in 24 hours.

Because of the high gloss and aesthetic value of the final epoxy ESD topcoat, extensive measures were taken to ensure that the absolute minimum amount of dust or debris would be introduced into the wet film. The installing contractor used tack mats at the entrance to the work area, plastic barriers to prevent debris from being kicked or tramped into the application surface, and all heating and ventilation equipment was turned off several hours prior to the application. The installing craftsmen wore clean-room-type boot covers as well.

Just prior to installing the final coat, workers conducted a multi-step cleaning process to ensure that no dust or debris remained on the surface. The surface was swept, vacuumed twice, and then damp-mopped to eliminate any surface contaminates. The floor was then finished with tack cloths immediately prior to the final coat being applied. The result was a high-gloss surface almost completely free of any defects—a very difficult task in an active construction environment.

The ESD coating system is a two-part application process. The first component of the system is a conductive primer that provides a positive path to ground throughout the coating system. The conductive primer was applied at 5 to 6 mils (0.1 to 0.2 mm) of wet film. Electrical ground points consisting of copper tape were placed at columns after the application of the conductive primer and before the final coat.

The final ESD topcoat is a 100% solids epoxy and was applied at 16 to 18 mils (0.4 to 0.5 mm) using a notched rubber squeegee and back-rolled with a nap roller. The final finish was a smooth, highly reflective, and easily cleanable surface. An unexpected benefit was the greatly increased room brightness level due to the reflectivity of the surface.

Final testing of the floor was performed after the final coat was allowed to fully cure. Testing was performed in accordance with ASTM STM 97.1 and STM 97.2. Testing of ESD performance includes measuring the electrical resistance of the floor surface to the building ground through a person wearing the appropriate ESD shoes or heel grounders. In addition, personnel wearing their normal work apparel are measured for body voltage generation while going through a series of movement tests. In both cases, the finished floor surface was certified effective in reducing body voltage generation to below the threshold limit. In combination with the other ESD mitigation methods employed by Garmin, they were able to determine with confidence that excessive development of static was reduced below the threshold of the most sensitive device in the work area.

The ESD floor system at Garmin has been in use for a year and will be reevaluated for ESD characteristics annually.

SPECIAL FEATURES

Close cooperation between Garmin, the general contractor, and the coating installer was vital for the successful completion of this project. Because of the close proximity of manufacturing operations, careful attention had to be paid to cleanliness and dust generation. In addition, the topping and coating materials were required to be low/no odor because of the adjacent production areas. The selection of water-based and solvent-free materials fulfilled these requirements and also provided the physical properties necessary for ESD performance.

The material selection was vital to the success of this project, both in installation and with respect to long-term performance. Because of the high potential cost of interrupting production, the product chosen had to have a history of long-term trouble-free performance. The high level of moisture in the substrate would very likely result in premature failure. Close cooperation between Garmin and the material manufacturer resulted in a product-based solution that met all requirements.

Material choice with respect to appearance was also very important. Meeting Garmin's requirements for levelness, gloss, and reflectivity required a smooth-flowing material that produced the necessary finish.

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