INDUSTRIAL FLOORING INSTALLATION CHALLENGES

James C. Ziegler, ArmorSeal Product Manager
Sherwin Williams
Cincinnati, Ohio, USA

Abstract: Specifier's and contractors not only need to properly evaluate the substrate, make proper system recommendations and pay attention to details during the installation, but they must also have an understanding of potential problems and their causes to aid in the successful installation of heavy duty floor coatings and systems. Understanding these issues minimizes problems and facilitates a successful installation.

Introduction

Heavy duty flooring systems and coatings can produce an aesthetically pleasing, chemical, wear resistant barrier that protects the concrete substrates. Concrete floors can be expensive to replace or maintain if proper care is not taken to protect them.

Even though concrete can be a very strong, hard substrate, unprotected concrete is subject to deterioration. Concrete is very porous and can be subjected to chemical attack and physical abuse. Coatings and surfacings are used to protect concrete, improve appearance and provide ease of maintenance.

Seamless floors are manufactured “in place”. The chemical reaction of the polymeric materials must be controlled for successful installation. Failures and challenges can occur prior to, during or after the installation. Many of these problems can be prevented.
When applying coatings and heavy duty flooring systems, it is important that the contractor strictly adhere to the application requirements for each product. Deviations from the manufacturer’s instructions and job site specifications may result in less than anticipated results. Avoiding these issues and preventing problems is the basis of an expert flooring contractor.

Substrate Evaluation

The first critical step in avoiding flooring problems is the evaluation of the substrate. Concrete, the primary substrate on which seamless flooring systems are applied, is porous. It breathes and absorbs liquids when exposed to the environment. This can present a problem both during and after the installation of a non-permeable fluid applied flooring system.

During the substrate evaluation process, responsible parties must determine whether an effective vapor barrier exists below the slab, what potential contaminants are in the concrete and the overall soundness of the concrete, including joint and crack movement.

The effects of moisture vapor emissions from the slab must be thoroughly evaluated. Remove contaminants from the substrate prior to the installation. Mechanical surface preparation may

remove some of the surface contamination, but chemicals and oils that penetrate the concrete substrate also must be removed or neutralized. Weak concrete must be replaced and spalls must be repaired with an appropriate mortar or compatible material to speed the repair and recoat times.

The foundation of any coating system is surface preparation. The purpose of surface preparation is to remove all contaminants such as concrete laitance, existing coatings, hardeners, sealers and curing compounds that can interfere with adhesion. Surface preparation also develops a surface profile to promote mechanical adhesion.

Although there are many methods of surface preparation available, shot blasting is normally the preferred method.

System Recommendation

No two flooring projects are ever the same and never as simple as they may first appear. Many contractors are asked to make product and system recommendations. Representatives from the manufacture may assist in making these recommendations.

Many factors need to be considered when making any recommendations:

- Shut-down time
- VOC's and odor tolerance
- Chemical resistance
- Wear and impact resistance
- Longevity of the system
- Thermal resistance
- Slip resistance
- Cleanabilty
- Light reflectivity
- Installation conditions such as temperature, humidity etc.

Problem Recognition, Causes, Prevention and Remediation

Contractors come across challenges everyday when applying industrial coatings and industrial flooring systems. Recognizing problems, causes, prevention and remediation is crucial for successful application.

Bubbles

Bubbles may appear as small as a pinhead or greater. They may appear throughout the entire coating or in clusters. (Figure 1)

FIGURE 1, Bubbles

Cause 1:
Air is entrained in the resin while mixing too aggressively, improper mixing speed and/or improper mixing equipment.

Prevention:
Use the proper mixing equipment for mixing industrial coatings, a variable speed drill at about 300-500 rpm with an appropriate mixing paddle such as a Jiffy Mixer

Cause 2:
Improper application techniques of materials by creating bubbles with the roller or squeegee.

Prevention:
Always use the manufacturer's recommended equipment. When using 100% solids material, spread with a squeegee, back roll with a high quality, lint-free, medium nap roller and use a spike or spiney roller to improve air release.

Cause 3:
Excessive heat will cause coatings and flooring systems to cure too quickly. Normal air in the coating cannot escape. Thus becoming entrapped and creating bubbles.

Prevention:
Try to avoid elevated temperatures. Monitor the environmental conditions, air, substrate temperatures and humidity. Condition materials for several hours prior to application.

Cause 4:
Direct sunlight will cause similar problems as excessive heat. The sunlight heats the top of the coating and cures the material from the top. This forms a skin, not allowing air to escape, creating bubbles.

Prevention:
Cover windows and doorways to prevent direct sunlight exposure to the coatings prior to, during and throughout the cure period.

Remediation:
Thoroughly abrade bubbled coating with sandpaper or a floor grinder, thoroughly vacuum area and solvent wipe with a strong, clean solvent recommended by the coatings manufacturer. Re-prime and recoat.

Outgassing

Air pockets in porous concrete escaping during the curing process, trapped in the film, creating bubbles. These bubbles typically have a pinhole that penetrates directly to the substrate. (Figure 2).

FIGURE 1, Outgassing

Cause:
When the air temperature above the substrate is warmer than the substrate temperature and the humidity is lower, the air trapped in the pores of the concrete expands and the air moves out of the concrete creating bubbles.

Prevention:
Check temperature and humidity conditions of the air and substrate. If the temperature is rising, do not apply coating. Wait to apply materials when the air temperature is falling. Double priming may also be helpful or using a water-based epoxy primer to seal off entrapped air in the concrete.

Remediation:
Thoroughly abrade affected coating with sandpaper or a floor grinder and thoroughly vacuum area and solvent wipe with a strong, clean solvent recommended by manufacturer. Re-prime using a high build, fast cure primer. Large craters may be patched with a quick set crack filler.

Poor Intercoat Adhesion

Poor intercoat adhesion occurs when one coating does not adhere to the previous cured coat. (Figure 3)

FIGURE 3, Poor Intercoat Adhesion.

Cause 1:
Improper preparation of the previous coating.

Prevention:
Prior to applying multiple coats of material, the previous coating must be properly prepared and free from contaminants. These contaminants include dust, dirt, water or amine blush, and all contaminants must be removed prior to coating.

Cause 2:
Recoating outside of recoat window. Most coatings have a range of time or recoat window when a subsequent coat can be applied without additional preparation.

Prevention:
Check the manufacturer's product data sheet for recoat window times. Do not exceed the recoat window. If the recoat window has been exceeded, consult manufacture's recommended recoat procedure.

Cause:
When coatings are installed at temperatures less than 5°F above dew point, moisture may condense on the surface acting as a bond-breaker and could cause inter-coat adhesion problems.

Prevention:
Check temperature and humidity of substrate and air to ensure the substrate temperatures are at least 5°F above the dew point.

Remediation:
Mechanically remove any poorly bonded coating. This may be achieved by shot blasting, grinding or sanding. Existing coating must have a dull surface from the mechanical preparation. Vacuum and solvent wipe existing coating to remove any dust, debris or other contaminants. Reprime and recoat according to the manufacturer's instructions.

Bond Failure at Substrate

Bond failure at the substrate occurs when the coating or flooring system delaminates at the bond line. (Figure 4).

FIGURE 4, Bond Failure at Substrate.

Cause 1:

Inadequate surface preparation, preventing a good mechanical bond or leaving a surface contaminant, which acts as a bond breaker.

Prevention:
The foundation of any coating or flooring system is the surface preparation. The purpose of surface preparation is to remove all contaminants such as concrete laitance, existing coatings, hardeners, sealers and curing compounds that can interfere with adhesion and develop a surface profile to promote mechanical adhesion.

Disbonding from the substrate at the termination or at transitions is related to the installation detail. Traffic edges require a keyed termination.

Remediation:
Mechanically remove coating or flooring system. The substrate must then be prepared by following manufacturer's recommend surface preparation guidelines.

Poor Hardness or Tackiness

After sufficient time, material has not developed proper hardness or may appear tacky on the surface. (Figure 5)

FIGURE 5, Poor Hardness or Tackiness

Cause:

Applying coatings when temperatures are below recommended minimum range. When temperatures are below the manufacturer's recommendation, materials may never completely cure.

Prevention:
Strictly adhere to manufacturer's recommended installation temperature guidelines. Monitor environmental conditions and select the correct products for the application.

Cause:
Improper mixing or measuring ratio.

Prevention:
Use proper equipment, accurately measure components and mixing procedures in accordance with the manufacturer's installation instructions. Mixing time, equipment, and procedures are very crucial and should not be deviated. Do not mix partial units if using small kits or different chemistries.

Remediation:
Remove any soft spots, contamination or dirt from the surface. This may have to be scraped away using a floor scraper or hand tools. Once excess material has been removed, solvent wipe to remove any residue. Once removed, mechanically prepare surface and recoat.

Amine Blush or Greasy Film on the Surface.

Amine blush is a normal chemical reaction between amine-curing agents and carbon dioxide when in the presence of moisture forming a carbonate, which appears as a greasy film on the surface. This is especially true at low temperatures and high humidity. (Figure 6)

FIGURE 6, Amine Blush

Cause:
Amines react with carbon dioxide and moisture to create a greasy, oily film on the surface.

Prevention:
Check environmental conditions and apply materials when the temperature is a minimum 5°F above dew point and rising. Do not use propane heat in closed environments because they emit CO2.

Remediation:
The amine blush or greasy film must be removed. Solvent wiping prior to the application of the next coat is also utilized, but it can leave residual contaminants if not thoroughly cleaned. It is best removed by using a hot water detergent scrub and rinse.

Fish-eyes

Fish-eyes are areas where the coating pulls away from the surface or previous coating. (Figure 7).

FIGURE 7, Fish-Eyes

Cause:
Contamination on the substrate or coated surface are frequently caused by blush, surface oils, animal fats, vegetable oil, grease, silicone or petroleum based products.

Prevention:
Prior to application of any coating, the substrate must be inspected for any contaminants including dirt, debris, amine blush or residues.

Remediation:
The surface must be thoroughly sanded or abraded to remove the contamination and to roughen the previous coat. Once the surface is mechanically prepared, solvent wipe to remove any dust, dirt or residual contamination, prior to recoating.

Disbonding in Form of a Blister

Moisture vapor transmission will cause loss of adhesion and blistering. The moisture in the pores of concrete will migrate toward the warm, dry air above the substrate. (Figure 8).

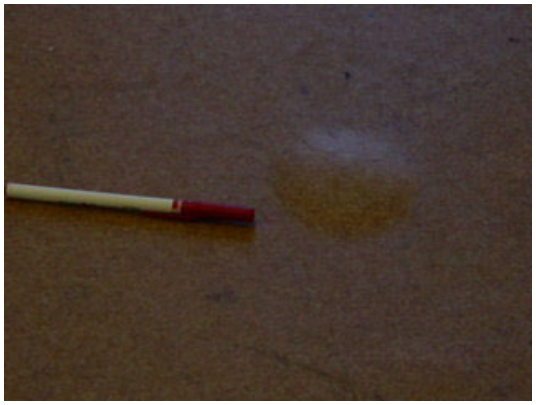

FIGURE 8, Disbonding from Moisture Vapor Transmission

Cause:
Moisture vapor transmission.

Prevention:
After surface preparation, the substrate must be tested for moisture vapor transmission with a calcium chloride test kit at "use" conditions. The results must generally be less than 3 pounds of moisture per 1000 square feet per 24 hours period. The coatings or flooring systems must also be installed at "use" conditions.

Remediation:
The flooring system must be removed. Raising the temperature and increasing the ventilation prior to retesting may help remove the excess moisture. Treating the surface with a penetrating silicate, siloxanes, or gel forming polymers may decrease the permeability and inhibit the path of moisture.

Color Shading

Uniform color but different shades of color, sometimes dark or light streaks appear in the film. (Figure 9).

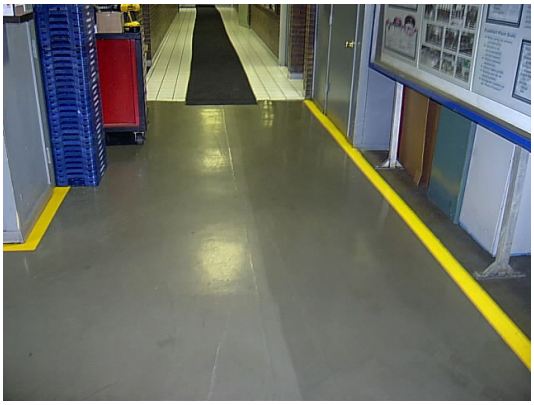

FIGURE 9. Color shading

Cause:
Using multiple batch numbers.

Prevention:
Check batches while staging the project. If there are multiple batch numbers, "boxing" batches together for uniformly of color.

Cause:
Improper mixing.

Prevention:
Always use proper mixing equipment when mixing industrial coatings and floor surfacing products. Use a variable speed drill, Jiffy mixing blade, on low speed. Premix material prior to adding multiple components together. Once premixed, slowly pour components together and mix for 2 to 3 minutes and until uniform. Carefully follow manufacturer's instructions.

Remediation:
Thoroughly abrade coating with sandpaper or a floor grinder. Thoroughly vacuum area and solvent wipe with a strong, clean solvent. Reprime and recoat.

Summary

Heavy duty flooring systems and industrial coatings require surface evaluation, accurate system selection and professional installation to prevent expensive problems. Taking the time and effort to understand the potential problems and implementing the correct measures to prevent them is the hallmark of a successful professional flooring installer.

Bubbles: Air bubbles may appear as small as a pinhead or greater. They may appear throughout the entire coating or in clusters.

Cause	Prevention	Remediation
-Air entrainment in the resins during mixing and or application	-Use manufacture's recommended equipment for mixing and application. When using 100% solids material, spread with a squeegee, back roll with a high quality, lint-free, medium nap roller and use a spike or spiney roller to improve air release.	Thoroughly abrade bubbled coating with sandpaper or a floor grinder, thoroughly vacuum area and solvent wipe with a strong, clean solvent recommended by manufacturer. Reprime and recoat.
-Excessive heat	- Try to avoid elevated temperatures. Monitor the environmental conditions, air, substrate temperatures and humidity. Condition materials for several hours prior to application.	
-Direct sunlight	- Cover windows and doorways to prevent direct sunlight exposure to the coatings prior to, during and through the cure period.	

Outgassing: Air pockets in porous concrete escaping during the curing process, trapped in the coating crating bubbles.

Cause	Prevention	Remediation
- When the air above the substrate is warmer than the substrate temperature and the humidity is lower, the air trapped in the pores of the concrete expands and the air moves out of the concrete creating bubbles.	-Check temperature and humidity conditions of the air and substrate. If the temperature is rising do not apply coating. Wait to apply materials when temperature is falling. Double priming may also be helpful or use a water-based epoxy primer to seal off trapped air in the concrete.	Thoroughly abrade bubbled coating with sandpaper or a floor grinder, thoroughly vacuum area and solvent wipe with a strong, clean solvent recommended by manufacturer. Reprime using a high build, fast cure primer. Large craters may be patched with quick set crack filler.

.

Poor Intercoat Adhesion: Poor intercoat adhesion is when one coating application does not adhere to the previous cured coating.

Cause	Prevention	Remediation
-Improperly prepared previous coating	-Prior to applying multiple coats of material, the previous coating must be properly prepared and free from contaminants. These contaminants include dust, dirt, water or amine blush, which must be removed prior to coating.	Mechanically remove any poorly bonded coating. This may be achieved by shot blasting, grinding or sanding. Existing coating must have a dull surface from the mechanical preparation. Vacuum and solvent wipe existing coating to remove any dust, debris or other contaminants. Reprime and recoat according to manufacture's instructions
-Recoating outside of recoat window. Most coatings have a range of time when a subsequent coat can be applied without additional preparation.	-Check manufacture's product data sheet for recoat window times. Do not exceed recoat window. If the recoat window has been exceeded, consult manufacture's recommended recoat procedure.	

Bond Failure at Substrate: Bond failure at the substrate occurs when the coating or flooring system delaminates at the bond line.

Cause	Prevention	Remediation
-Inadequate surface preparation preventing a good mechanical bond or leaving a surface contaminant, which acts as a bond breaker.	- Remove all contaminants such as the concrete laitance, existing coatings hardeners, sealers and curing compounds that can interfere with adhesion and develop a surface profile to promote mechanical adhesion.	Mechanically remove coating or flooring system. Then the substrate must be prepared by following manufacturer's recommend surface preparation guidelines.

Poor Hardness or Tackiness: After sufficient time, material has not developed proper hardness or be tacky on the surface.

Cause	Prevention	Remediation
-Applying coatings when temperatures are below recommended minimum range. When temperatures are below manufacture's recommendation, materials may never reach complete cure.	-Use proper equipment; accurately measure components and mixing procedures in accordance with manufacture's installation instructions.	Remove any soft spots, contamination or dirt from the surface. After excess material has been removed, solvent wipe to remove any residue. Once removed, mechanically prepare surface and recoat.

Amine Blush: Amine blush is a normal chemical reaction between amine-curing agents and carbon dioxide when in the presence of moisture form a carbonate, which appears as a greasy film on the surface.

Cause	Prevention	Remediation
Amines react with carbon dioxide and moisture to create a greasy, oily film on the surface.	-Check environmental conditions and apply materials when the temperature is a minimum 5°F about dew point. Do not use propane heat in closed environments.	The amine blush or greasy film must be removed. It is best removed by using a hot water detergent scrub and rinse. Solvent wiping prior to the application of the next coat is also utilized, but it can leave residual contaminants if not thoroughly cleaned.

Fish Eyes: Fish-eyes are areas where the coating pulls away from the surface or previous coating.

Cause	Preventions	Remediation
-Contamination on the substrate or coated surface are frequently caused by blush, surface oils, animal fats, vegetable oil, grease, silicone and petroleum based products.	-Prior to apply any coating the substrate must be inspected for any contaminants including dirt, debris, amine blush or residues.	The surface must be thoroughly sanded or abraded to remove the contamination and to roughen the previous coat. Once the surface is mechanically prepared, a solvent wipe to remove any dust, dirt or residual contamination must be done prior to recoating.

Disbonding in form of a blister: Moisture vapor transmission will cause loss of adhesion and blistering. The moisture in the pours of concrete will migrate toward the warm, dry air above the substrate.

Cause	Prevention	Remediation
-Moisture vapor transmission	-After surface preparation, the substrate must be tested for moisture vapor transmission with a calcium chloride test kits at "use" conditions. The results must generally be less than 3 pounds of moisture per 1000 square feet per 24 hours period. The coatings or flooring systems must also be installed at "use" conditions.	The flooring system must be removed. Raising the temperature and increasing the ventilation prior to retesting may help remove the excess moisture. Treating the surface with a penetrating silicate, siloxanes, or gel forming polymers may decrease the permeability and inhibit the path of moisture.

Color shading: Difference in shades of color.

Cause	Prevention	Remediation
-Using multiple lot numbers.	-Check batches while staging the project. If there are multiple batch numbers, "boxing" batches together for uniform color.	Thoroughly abrade coating with sandpaper or a floor grinder, thoroughly vacuum area and solvent wipe with a strong, clean solvent. Reprime and recoat.
-Improper mixing.	- Always use proper mixing equipment when mixing industrial coatings and floor surfacing products. Use a variable speed drill, Jiffy mixing blade, on low speed. Premix material prior to adding multiple components together. Once premixed, slowly pour components together and mix for 2 to 3 minutes and until uniform. Carefully follow manufacture's instructions.	