

## ***Installation of Dry Shake Hardeners***

*Dry shake hardeners have been used for years to strengthen, increase ductility or increase abrasion resistance in industrial floors. Today they are also used to increase light reflection, diffusion and to produce architectural effects.*

The use of dry shake hardeners mandates that the concrete will not inhibit the use of the dry shake and applicators are; well equipped, knowledgeable of concrete, placing, consolidation, installing a dry shake, finishing, curing and protection.

It is ultimately important to ensure the concrete mix design for concrete slabs that are to receive a dry shake floor hardener conform as close as possible to the below recommendations and general guidelines.

Failure to have a concrete mix designed exclusively for performance in conjunction with dry shake hardeners can result in problems including; difficulty in finishing, delaminations as well as blistering of the dry shake.

### **Concrete Mix Design Guidelines:**

The following recommendations are general guidelines, and are not to be construed as absolutes, but are to be used as guidelines only:

- Water Maximum 300 lbs
- Cement Type I or I-II 600 lbs
- Coarse Aggregate, approximately 1,850 – 2,000 lbs,
- Fine Aggregate, approximately 1,000 – 1,200 lbs
- Water/cement ratio 0.50

**Note:** The above mix represents a Water to Cement (W/C) ratio of 0.50. The aggregate ratio (fine aggregate ÷ total aggregate) is calculated at approx. 0.45 to 0.40. Gap grading the aggregates should be

avoided as much as possible. Mixes with gaps, or voids in their aggregate gradation (gap graded mixes)

create major difficulties in placing, as gap graded mixes should be placed at “0” slump to avoid segregation. Concrete slump should be not greater than 5 inches, and the concrete should have a minimum compressive strength of 4,000 psi. Concrete mix designs, placement/finishing should be performed in accordance with the guidelines of **ACI 302**.

### **Concrete Admixtures:**

#### **Air Entrainment:**

None preferably, 2-3% maximum, if air entrainment exceeds 3%, it can seriously affect the performance of the dry shake material, and cause stickiness which intern causes stretching (tensile stresses) in the finishing process. Air entrainment also severely diminishes and slows the availability of bleed water. Dry shakes must have bleed water if they are to develop a bond to the concrete.

#### **Water Reducers:**

- Not recommended, particularly “Type F” reducers, which are hydrophilic in nature, and can result in reduced bleeding.

#### **Accelerators:**

- Not recommended. Chloride type accelerators are absolutely forbidden for use with a metallic dry shake as corrosion of the metallic aggregate will occur.

#### **Retarders:**

- Not recommended if color is an issue, but could be considered in hot, dry weather.

#### **Micro Silica:**

- Maximum less than 10% of cement weight. Micro-silica creates great difficulties in finishing, and has a high water demand.

## ***Dry Shake Hardeners Continued***

### **Fly Ash:**

- Maximum of 12% of the weight of the cement. Fly ash can decrease the potential for efflorescence, but it has a high water demand, which can decrease the water available for bleed to wet out the dry shake material.

### **Fibers:**

- Not recommended

### **Vapor Barrier/ Retarder**

Vapor barriers/ retarders and vapor barriers with aggregate cushions are often specified for slabs on the ground. Vapor Barriers force all bleed water to evaporate through the top surface of the concrete. Due to the fact that all water of convenience must exit through the top of the placement, vapor barriers/ retarders slow down bleeding and setting of the top surface for extended periods.

A vapor barrier with an aggregate cushion is usually a 2" layer of aggregate similar to ASTM D448 #10 material over the vapor barrier. This allows some absorption of the water of convenience to migrate downward and the balance of the bleed water of convenience must exist through the top of the placement.

### **Mock Up**

It is recommended that a minimum 10' x 10' (3.0 m x 3.0 m) test placement (mock up) be made using the same applicator, concrete mix proportions, method of placement and finishing procedures and the same conditions as anticipated on the project. . This mock up can be used to evaluate the bleeding characteristics of the concrete and finishing of the dry shake material under the prevailing ambient conditions and equipment. The mock up sample area should be to assure acceptance of installation and appearance.

### **Equipment:**

The highway straight edge is not just for highways any longer, and when used on a dry-shake application it flattens out the ridges produced by the transverse motion of a strike-off. The highway straightedge is also an excellent tool for removing excess bleed water from the concrete surface with little if any scaring of the surface. The highway straight edge is approximately a 2x4 or 2x6 depending upon the overall length of the straight edge. The wider side of the straight edge assists in embedding the dry-shake, *if the concrete will support it in that direction without jiggling*. It should be used in the small direction only when removing excess bleed water.

Mechanical spreaders such as A Somero, Morrison, or Ray Haid Construction Ltd. or other quality mechanical spreader should be used to disperse the required amount of the dry-shake.

Wood bull floats do not prematurely seal the concrete surface, where a magnesium bull float can. Until the second application of a dry shake, the wood bull float should be used, *only without jiggling*. The wood bull float is almost impossible to push or pull across a concrete surface without tearing the concrete surface when; air-entrainment agents, rich mixes, or micro-silica are used in a mix.

Steel or magnesium bull floats should not be used until after the second application of dry shake has been installed. Jiggling of a bull float decreases flatness by at least 30%. The less flatness a surface has, the more dry shake it takes to fill in the voids, and the thicker it is places in one pass the greater the potential for delamination. Vibratory bull floats should only be used for initial strike-off or after the second application of dry shake.

## ***Dry Shake Hardeners Continued***

**Wood or magnesium darbys** should only be used when there is no alternative, around drains etc.

**Fresno's** should not be used on industrial floors.

**Kelley floats** were designed for industrial floors. They were used to imbed slivered slag into industrial floors. Kelley floats were designed to be weighted to different weights so that the dry shakes could be imbedded into concretes of varying stiffness.

**Power trowels** and **float blades** should be used as close to flat to the concrete surface as possible. Pitch on a float blade causes disruption of the coarse aggregates, which can cause blisters or pop-outs. Pop-outs are aggregates near the surface that have been disturbed either mechanically or through absorption and freeze-thaw. Float blades are bent plates with all sides curled up so they will not dig into the concrete.

**Trowel blades** are not curled and look like a hand trowel. Trowelling is done only when pitch is applied to the blades, or when the concrete is sufficiently hard to allow a pitched blade to densify, not tear into the concrete surface. The degree of pitch is a function of the concrete surface hardness.

**Combination blades** are clip on blades that are intended to do two functions. Tools that attempt to do two functions are rarely as effective at either function as a single application tool. Combination blades should be avoided on dry-shake jobs.

A **pan** is an attachment to trowel blades that absolutely keeps the float flat to the concrete surface and can be a good investment. However, there are some specialists in the field that recommend first using float shoes, then use the pan rather than doing all the floating with just the pan.

**Hand floats, trowels** and **burnishing tools** come in a variety of sizes, compositions and qualities. When a triple trowelling is required, and the work is to be done by hand, a finisher requires three different trowels that are both shorter and narrower than the first is the second and the second to the third. Physically as the concrete hardens, it is impossible to increase pressure with a long, wide trowel to achieve the desired finish.

**Hand edgers** should not be used at construction joints unless called for by specification. They can greatly disturb both flatness and levelness.

**Hand jointers** are extremely difficult to use when either the 1/3 or 1/4 depth of joint is required. Hand jointing should not be attempted on dry shake jobs unless it is a very small placement. Sawing joints is more common in dry shake applications.

### **Coverage Rates:**

The concrete slab on grade placement should be placed, screeded, and then receive the dry shake floor hardener in two passes as recommended by ACI 302. The first pass at 2/3, and the second and last pass at the final 1/3 of the total broadcast weight. The use of a vibratory and or LAZER screed will greatly enhance the strike off and consolidation of the fresh concrete placement in preparation for the dry shake placement. Actual applied coverage rates should conform to the published coverage rates provided by the respective dry shake technical bulletin.

A Somero, Morrison, or Ray Haid Construction Ltd. or other quality mechanical spreader should be calibrated to drop the required amount by weight of the dry shake powder, while the slab edges would be broadcast evenly by hand during initial floating operations.

## ***Dry Shake Hardeners Continued***

### **Calibration of the Mechanical Spreader:**

A quality calibrated weighing scale capable of reading to the nearest 1/8 of a pound must be on hand to weigh the calibration plate. The mechanical spreader should be calibrated using a 1sq. ft. wood, steel, or strong cardboard as the

calibration plate. The plate must be weighed before dropping the shake so as to tare (subtract) the weight of the calibration plate itself.

### **General Application Procedure:**

#### **Mineral-Aggregate Dry Shake Hardeners**

#### **Information per ACI 302.1 chapter 8.6.1 "Embedded Mineral Aggregate Hardner"**

The application and finishing of embedded mineral-aggregate hardners should follow the basic procedures outlined below. Concrete installations are subject to numerous conditions and variables.

Experience is necessary to determine proper timing for the required procedures. It is recommended that these procedures are used in the site mock-up, discussed and agreed upon at the pre-construction meeting.

1. Place, consolidate, and strike off concrete to the proper grade.
2. Compact and consolidate the concrete surface using a bull float.
3. Restraighten the surface using a modified highway straight edge. Occasionally, the compacting, consolidating and straightening are accomplished in one step by using a wide bull float or a modified highway straight edge with the straightedge rotated so its wide dimension is in contact with the surface.
4. Evenly distribute approximately 2/3 by weight, of the mineral-aggregate hardner immediately

following the re-straightening operation, and prior to the appearance of bleed water on the slab surface. *Do not broadcast directly into bleed water.* Distribution of the hardner by mechanical spreader is the preferred method while the slab edges would be broadcast evenly by hand. The concrete mixture should have proportions such that excessive bleed water does not appear on the surface after application of the hardner.

5. As soon as the hardner darkens slightly from absorbed moisture, a weighted wood bull float or modified highway straightedge should be used to embed the hardner as well as to remove any irregularities in the surface. The wet out time will be affected by ambient job-
6. site conditions, and slightly shorter or longer times may be necessary. Avoid clumping material on the surface.
7. Wait until the concrete sets up sufficiently to support the weight if a power trowel with the float shoes or pan attached. *Combination blades should not be used.* The float breaks the surface and agitates the concrete paste at the surface of the slab. The first power-float passes should be across the placement strip in the short direction. This will ensure that irregularities can be easily identified and corrected in subsequent operations.
8. Apply the remaining 1/3 (by weight) of the specified mineral aggregate, preferably at right angles to the first application. The second application does not have to be applied at right angles to the first application if a mechanical spreader is used.
9. Re-straighten the surface using a modified highway straightedge. Remove irregularities and move excess material to low spots.

## Dry Shake Hardeners Continued

10. Embed the mineral-aggregate fines using a power trowel with float shoes or a pan attached. *Early setting around the slab edges will occur and should be watched closely to properly time the floating operation.*
11. Re-straighten the surface following the power-floating operation using a weighted modified straightedge if its use is seen to be effective or necessary to achieve required surface tolerances.
12. Continue finishing with multiple power-trowelling as required to produce a smooth, dense, wear resistant surface (section 8.3.11). Initially, the trowel blades should be set as flat as possible to avoid digging into the surface. The trowel blades may be gradually raised to slowly close the surface. Proper and uniform finishing is essential at this point. Provide a burnished (hard) trowelled surface where required by specification. *Do not rewet and do not overwork. Prevent closing the slab too early as blistering or delamination may occur. Do not use combination blades.*
13. Cure immediately after finishing by following the curing material manufactures recommendations. Curing methods should be in accordance with those used and approved in construction of any test panel.

### General Application Procedure:

#### Metallic and Colored Dry Shake Hardeners

Information per ACI 302.1 chapter 8.6.2 "Metallic Dry-Shake Hardners and colored Dry Shake Hardners"

Unlike the mineral aggregate dry shakes, metallic and colored dry shakes (light reflective) are to be broadcast *after* the concrete bleed water has

dissipated, and immediately after the concrete appears to have lost its surface sheen. Broadcasting the metallic/colored dry shake before bleed water dissipation will dull, darken, or gray-up the color, as the dry shake can somewhat mix or integrate with the concrete's top surface cement paste. The remaining application of the hardener is in the same manner as the mineral-aggregate shakes up until the final finishing. Colored dry shake applications should not be burnished or hard troweled as discoloration may occur. Plastic or stainless steel blades are recommended for the light reflective applications; plastic being the optimal choice. The use of metal shoes may cause the surface to darken.

1. Place, consolidate, and strike off concrete to the proper grade.
2. Compact and consolidate the concrete surface using a bull float.
3. Restraighten the surface using a modified highway straight edge. A wide bull float or a modified highway straight edge can be used to accomplish both steps in one operation
4. Open the surface to promote movement to bleed water to the top of the slab by using a wooden bull-float. Steps 3 & 4 can be accomplished in one operation if the wide bull float or modified highway straightedge is made of wood.
5. Wait until the concrete sets up sufficiently to support the weight of a power trowel.
6. Break the surface using a power trowel with float shoes or pan attached.
7. Evenly distribute approximately 2/3 (by weight) of the specified metallic dry hardner or colored dry-shake hardner. Application of the

## ***Dry Shake Hardeners Continued***

material by mechanical spreader is the preferred method while the slab edges would be broadcast evenly by hand.

8. Re-straighten the surface after application of the metallic dry-shake hardner or colored dry-shake hardner to remove irregularities. Some contractors find the embedding the materials and restraighting can be accomplished in one step using a modified highway straightedge.
9. Complete initial embedment and prepare the surface for additional martial by using a power trowel with float blades or a pan attached. *Combination blades should not be used.* The float breaks the surface and agitates the concrete paste at the surface of the slab. The first power-float passes should be across the placement strip in the short direction. This will ensure that irregularities can be easily identified and corrected in subsequent operations.
10. Apply the remaining 1/3 (by weight) of the specified amount of metallic dry-shake or colored dry shake hardner, preferably at right angles to the first application.
11. Embed the metallic aggregate or colored dry-shake hardner using a power trowel with float shoes or a pan attached. **Thorough embedment and intergration of the metallic dry-shake hardner or colored dry-shake hardner with the concrete by floating is very important. Failure to accomplish this goal can result in blistering or delamination of the slab.**  
*Early setting around the slab edges will occur and should be watched closely to properly time the floating operation.*
12. Re-straighten the surface following the power-floating operation using a weighted modified highway straightedge if effective.
13. Continue finishing with multiple power-trowelling as required to produce a smooth, dense, wear resistant surface (section 8.3.11). Proper and uniform finishing is essential. Colored surfaces should not be burnished (hard-trowelled); the result would be uneven color and a darkening of the surface. *Do not rewet and do not overwork. Prevent closing the slab too early as blistering or delamination may occur. Do not use combination blades.*
14. Cure immediately after finishing by following the curing material manufactures recommendations. Curing methods should be in accordance with those used and approved in construction of any test panel. Colored floors should not be cured with plastic sheeting, curing paper, or wet burlap. These materials promote uneven color, staining or efflorescence.

### **Dry Shake Notes & Recommendations:**

As a general guide to floor and slab construction and the application of the dry shake hardener refer to American Concrete Institute (ACI) 302 and to the technical data sheet for that specific dry shake hardener. Contractors involved with the placement and finishing of concrete slabs and or dry shake hardeners must be familiar with the guidelines provided by ACI 302.

All work should be performed under roof if possible to avoid the drying effects of wind and direct sunlight. Job conditions that affect drying/setting time also affect the dry shake application timing.

## ***Dry Shake Hardeners Continued***

Placement of the concrete and dry shake during nighttime or early morning hours will aid in curtailing evaporation related problems from any sun and resultant higher temperatures.

During hot, dry, or windy conditions, use the AquaFilm™ Concentrate J74 or the AquaFilm™ J74RTU evaporation reducer, in accordance with the instructions in their current technical data sheet, to reduce moisture loss and extend concrete workability.

Periodically check the calibration of the spreader as the job progresses. **Installation of too much Dry Shake Hardener in one pass can lead to delaminations or blistering in the finish as well as a waste of material.**

Metallic Dry Shakes and light reflective or colored mineral dry shakes must be broadcast into the concrete after the bleed water has dissipated and immediately after the concrete has lost its water sheen. The metallic, colored, & light reflective dry shakes must be broadcast later in time, after dissipation of the bleed water VS the mineral dry shakes due to the greater density of the metallic aggregates.

Broadcasting of metallic dry shakes before bleed water appearance as in the case of mineral dry shakes will lead to the much heavier (denser) metallic aggregates sinking into the fresh concrete.

Float and finish the hand broadcast edges around the slab first, as they will start to dry out first. Finishing around the slab perimeter is usually done by hand, but power floats can be used.

Use only plastic float shoes when finishing a white, light colored, or light reflective dry shake. The use of metal shoes will cause the light or otherwise colored dry shake surface to darken.

Do not attempt to close off the surface too soon as this will lead to trapped bleed water and subsequent delaminations. Dayton Superior does not suggest the use combination blades for any dry-shake operation.

***Specific Site ambient conditions will dictate the actual timing of the dry shake placement and finishing operations.***

### **Final Finishing and the Use of a Evaporation Reducer:**

An evaporation reducer such as the Dayton Superior, AquaFilm J74 or Ready-to-Use helps to produce dense, high quality concrete flatwork by greatly reducing the rate of evaporation of moisture from the concrete surface during the finishing process. This reduction of moisture loss allows time for proper finishing, while reducing plastic shrinkage cracking. AquaFilm J74 is outstanding in reducing loss of surface moisture during rapid drying conditions such as; hot temperatures, low humidity, high winds, direct sunlight, inside applications heated in winter, low water-cement ratio concrete applications, shake-on floor hardener or toppings applications

### **Curing the Dry Shake:**

As dry-shake applications work the concrete surface more than a typical slab, the timing of the commencement of curing is more critical. Consider using an ASTM C 309 curing compound/agent, but dry shakes can also be wet cured. The use of plastic sheet (Visqueen) over the slab to facilitate the cure may cause mottling especially on light colored or light reflective shakes. When using a curing compound for a dry shake, the curing agent should always meet ASTM C309.

Curing compounds such as Clear Cure J11W or Clear Cure VOC J7WB must be applied to a moist surface as they will impregnate the dry surface producing an organic impregnation.

## ***Dry Shake Hardeners Continued***

Dry concrete will absorb organic materials (dissipating resins), and organic impregnation severely weakens the surface strength and abrasion resistance.

### **Control/ Contraction Joints:**

Control/contraction floor joints must be cut into the floor slab at the proper spacing and depth to facilitate the control of random cracking. It is recommended that the joints be soft cut early on after final finishing and or curing compound application. Follow the guidelines of ACI 302 for recommendations on the cutting of control joints.

### **Liquid Hardners:**

Liquid Hardners such as the Sure Hard J17 or Pentra-Hard Densifier are able to penetrate deeper on dry, hardened concrete. Liquid hardners migrate into the pores and capillaries of concrete, react with the free lime, gel and harden, densifying the concrete surface. In a dry shake application, when done correctly, will have fewer pores and capillaries than a typical slab, therefore it will take less material than a typical application.

### **Common Defects & Blemishes in Finished Dry Shake Applications:**

Delayed curing accounts for many of the blemishes and defects in a dry shake application, this includes; plastic shrinkage cracking, crazing, dusting and checking.

Blistering of a dry shake is generally a result of bleed water being trapped by premature sealing of the surface.

Curling at joints is the result of differential drying and the resultant shrinkage. If the bottom of a slab is on a vapor barrier, or is on moisture saturated ground; to off-set curling, the curing membrane must be as

impervious to evaporation of moisture as the bottom. Curling can also be addressed in the mix design by decreasing the shrinkable materials in the mix design to the bare minimum.

Delamination of a dry shake is generally the result of lack of wetting of the dry shake by the water of convenience. In addition the previously listed problems can, and sometimes does contribute to dry shake delamination.

Small light or dark spots are often the result of moisture saturated, or moisture starved piece of aggregate that either bleeds or removes water from the dry shake at a specific spot. These spots are rarely larger than a quarter.