

Memorandum

ARUP

To	Josh Willhite, FRA	Date July 06, 2018
Copies	Tracy Lundin, Doug Pelletier, David Vardiman, Syd De Vries	Reference number 258706
From	Ian Buckley	File reference 4-05.5
Subject	Market Study for Dust-Proofing of Experiment Cavern Slabs and Shotcrete Walls	

1 Introduction

Arup USA, Inc (Arup) have been asked to comment on the viability and likely cost for application of a surface dust sealant to the concrete surfaces within the experiment caverns.

The concrete surfaces provided within the experiment caverns fall into two types:

- a) Regular slab surfaces which will consist of troweled smooth surfaces on the tops of all slabs and localized pad foundations within the caverns.
- b) Shotcrete surfaces to the side walls and overhead locations

The timing of the application of the surface dust sealant has also been considered in this study (i.e. whether the sealant is applied as works progress within the excavation and shotcreting of the caverns or whether this is considered a separate exercise when the caverns have been fully formed).

As the surface roughness has a direct impact on the rate of application of any product, the option to provide a smoothing layer of fine graded shotcrete has been considered.

This memo is structured as follows:

- Section 2 – Description of Available Products and Application
- Section 3 – Impact of Surface Roughness for Shotcrete Walls
- Section 4 – Sequencing
- Section 5 – Cost Comparison
- Section 6 – Conclusions
- Attachments:
 - Attachment 1: Data Sheet for MasterKure HD 100 WB
 - Attachment 2: Data Sheet for Ashford Formula
 - Attachment 3: Surface Coverage Information
 - Attachment 4: Cost Breakdown

Memorandum

2 Description of Available Products and Application

The requirement for dust-sealing of concrete surfaces is a relatively common requirement within building projects and is primarily associated with sealing of slabs due to the impacts of trafficking of these areas, which will cause any dusting of the surface to easily become airborne particles.

Typically, products are applied via a brush or sprayed onto the surface. Manufacturers normally allow both forms of application. For vertical or overhead surfaces, the use of spray application techniques are considered the most appropriate.

There are multiple products available on the market, and we have spoken directly with the technical departments of several of the large suppliers. Unfortunately, it quickly became clear that there is little data available for the specific use of dust sealant products on shotcrete walls. This is primarily because shotcrete surfaces are not usually used as the final finished architectural surfaces within most controlled environments (e.g. utility rooms within underground facilities would typically formed from CMU within a larger excavation, or a station box may have a formed concrete liner wall, or precast concrete segments may form the final finished surface in a tunnel). Typically, where shotcrete is left exposed it is within an uncontrolled environment.

The above being stated, the feedback we received from manufacturers was very positive. There is no technical reason why the products which are originally designed for coverage of slabs cannot be equally applied to the surface of shotcrete. The interaction between the product and concrete substrate would be the same, which leads us to conclude that the efficacy of the product would be the same.

Exact recommended coverage rates vary by product. We include technical information for the following products as attachments below:

- BASF - MasterKure HD 100WB (Attachment 1)
- Curecrete - Ashford Formula (Attachment 2)

Both these products are considered appropriate for the required performance. We have also obtained written confirmation from each manufacturer that their product can be used on shotcrete which is included behind the product data located in the relevant attachments below. Curecrete have an additional requirement that no Shrinkage Reducing Admixtures are used in the shotcrete design. This requirement is noted and will be incorporated within the final shotcrete mix design as good practice.

We also approached Sika but were unable to obtain any technical comment on their product's coverage rates so had to exclude them from this study.

Surface coverage rates are reasonably well understood for slabs, with available information from both suppliers. For application on vertical and overhead surfaces there is an increase in the amount of product required which we based upon the BASF product data. There is also an increase in material needed for rough versus smooth concrete. We have adopted a surface roughness for the vertical and overhead surfaces that are 7.5 times more rough than slab surfaces, which is dependent on the use of a surface regulating layer in the shotcrete (see discussion in Section 3 below).

The following application rates have been taken from the supplier's data (Table 1):

Memorandum

Table 1 - Avg. Sealant Use by Surface Type and Product

Product	Rate of Application on Slabs (ft ² /gal)	Rate of Application on rough surfaces - shotcrete (ft ² /gal)
BASF - MasterKure HD 100WB	300	40
Curecrete - Ashford Formula	200	27

3 Impact of Surface Roughness for Shotcrete Walls

Based on Arup’s experience of application of paint systems to finished shotcrete linings, it is clear that there could be a significant uptick in the surface coverage rates for any proposed product when used on shotcrete surfaces when compared to smooth floated slabs or formed surfaces which are well understood, as described in the previous section.

In order to reduce this impact, previous projects have sometimes utilized a regulating layer of shotcrete (i.e. a layer for smoothing the surface). The regulating layer would be based on a different concrete mix design which would consist of a much larger percentage fines content, in order to achieve a lower surface roughness, and by extension significant improvement in coverage rates.

This regulating layer replaces the top 1” of the typical structural layer mix with a structural finishing layer after the design thickness of shotcrete has been applied, and prior to application of the surface sealant.

Technical information from BASF provided in Attachment 3 indicates a typical saving of 50% material coverage when compared to untreated shotcrete. This is based on a dry powder application of Masterseal 345 waterproofing product, but it is considered the results would be similar for surface dust sealants.

4 Sequencing

For the slabs there are no specific sequencing issues. The surface sealant is applied after the troweling and curing of the slab surface. The surface is easily accessible, and this task occurs at the end of the formation of the structural works to the caverns. Light troweling is better than over-troweled surfaces, as the latter increased the volume of surface sealant needed.

To better utilize the dustproofing material, we considered the following two scenarios as part of this study:

- A) The shotcrete surface will be a typical shotcrete surface, which will be applied in one layer, as the work progressing. However, as the works are still progressing and creating a significant amount of additional dust which could adhere to the treated surfaces, therefore a final wash-down of the surfaces needs to occur at the end of the excavation works. The impact of water jets on the surface

Memorandum

sealant needs to be considered, and a scaffold or other working platform will be needed to gain access for the final cleaning work.

- B) The shotcrete surface will be consisting of the typical structural shotcrete mix, with an inch structural fines mix, which will allow the dustproofing material to cover more area. Per the previous option a working platform will be needed to gain access for the final cleaning work, and it is considered that this access should also be sufficient to allow the application of a sprayed surface sealant.

As a result of our investigation, it was concluded that Option B should be adopted as the most efficient approach, as shotcrete crews can work behind one another with only small adjustments in the scheduling.

5 Cost Comparison

A cost estimate was developed for the shotcrete and sealant options considered in this memo and presented in the following Table 2. The costs represent a Level 4 construction cost estimate in line with the accuracy ranges as defined by the AACEi.

Table 2 - Cost Estimate for Options

Estimate Items	BASF		Ashford	
	Option 1: 4"	Option 2: 3+1	Option 1: 4"	Option 2: 3+1
Opt 1: Shotcrete Structural Layer 4"	\$2,120,643		\$2,120,643	
Opt 2: Shotcrete Structural Layer 3"		\$1,640,753		\$1,640,753
Opt 2: Shotcrete Fine Leveling Layer 1"		\$546,918		\$546,918
Remove dust from chamber, wash walls	\$87,792	\$87,792	\$87,792	\$87,792
BASF Walls: Opt 1	\$2,226,175			
BASF Walls: Opt 2	\$-	\$1,484,116		
BASF Floors	\$239,447	\$239,447		
Ashford Walls: Opt 1			\$3,324,049	
Ashford Walls: Opt 2				\$2,243,733
Ashford Floors			\$242,270	\$242,270
Total Cost	\$4,674,058	\$3,999,026	\$5,774,755	\$4,761,466
Avg \$/SF	\$21	\$18	\$26	\$22

The estimate is based on the following assumptions:

- Option 1 assumes that one crew would place a 4" layer of structural shotcrete in a linear fashion
- Option 2 assumes that a single crew would place a 3" layer of shotcrete, then return and place a 1" layer of shotcrete with a fine aggregate mix.
- The unit rates for the shotcrete materials are similar, though placement productions slightly faster for Option 1; respectively 10 cy per hour and 9 cy per hour.
- Material unit rates for both the BASF and Ashford sealant materials have been obtained from the manufacturer websites. It is assumed that bulk purchases in 55 gallon drums would be

Memorandum

appropriate, though the contractor may be able to get better pricing due to bulk purchasing. This analysis assumes \$10/gal for BASF and \$12/gal for Ashford.

- The driving factor of the sealant cost is the installation production rate. An assumed production rate of 10 days per single chamber would be acceptable for the BASF formula in Option 1. A factor based on the coverage ratio was then used to derive the production rates for the Option, as well as the Ashford material. The assumed production rates are presented in the following Table 3.

Table 3 - Avg. Sealant Production Rate SF per Day

SF/ Day	BASF	Ashford
Option 1	4,391	2,964
Option 2	6,587	4,391

6 Conclusions

The application of a smoothing layer to the shotcrete will save time and material during the sealant application process, however the additional shotcreting layer is in itself a time consuming and costly exercise that must be considered.

While any direct data for the impact of usage rates for surface sealants does not exist, our experience of other products (paints etc.) plus the little amount of published data that exists and is deemed applicable, indicate that the likely range of saving is only in the range of 50%.

Cost analysis shows that the savings would need to be much larger to justify the application of the smoothing shotcrete as part of the process. This equation could only be changed if the smoothing shotcrete could impact the thickness of base shotcrete.

The viability of applying a surface sealant to shotcrete is understood from our investigations and multiple discussions with product manufacturers to be accepted as achievable, and is recommended using a sprayed application process.

There are multiple products available on the market which give us confidence that product availability and price will not create any significant risk to achieving this technical requirement.

Memorandum

Attachments

- Attachment 1: Data Sheet for BASF – MasterKure HD 100 WB
- Attachment 2: Data Sheet for Curcrete – Ashford Formula
- Attachment 3: Surface Coverage Information
- Attachment 4: Cost Comparison

Memorandum

Attachment 1: Data Sheet for BASF MasterKure HD 100 WB

MasterKure[®] HD 100WB & 100C

Concrete hardener and dustproofer

FORMERLY SONOSIL[®] AND SONOSIL CONCENTRATE

PACKAGING

MASTERKURE HD 100WB

5-gallon (18.9 L) pails
55-gallon (208 L) drums

MasterKure HD 100C:

11 gallons (41.6 L) in a 55-gallon
(208 L) drum; must be filled with soft
potable water prior to use.

COLOR

Clear liquid

YIELD

See Chart on page 3.

STORAGE

Store in unopened containers in a
cool, dry area between 35 and 85° F
(4 and 29° C). Keep from freezing.

SHELF LIFE

15 months when properly stored.

VOC CONTENT

0 g/L, less water and exempt solvents.

DESCRIPTION

MasterKure HD 100WB is a sodium silicate-based concrete hardener and dustproofer that bonds chemically with the concrete to strengthen and harden floors that are porous, readily absorptive, and only moderately hard.

PRODUCT HIGHLIGHTS

- Hardens and densifies concrete floors to reduce absorption and prolong service life
- Non-film forming, resulting in reduced cleaning and maintenance costs
- Quick-drying for fast turnaround
- Residue-free for compatibility with most resilient floor-covering adhesives

APPLICATIONS

- Interior and exterior
- Floors and walls requiring a harder, easier-to-clean finish
- Docks and ramps

SUBSTRATES

- Freshly placed concrete
- Newly cured bare concrete
- Aged concrete
- Terrazzo (non-resinous)

HOW TO APPLY

SURFACE PREPARATION

GENERAL CLEANUP

1. Surfaces must be clean, dry, and free of contaminants, including parting compounds.
2. Rinse, then remove surface water.

FRESHLY PLACED CONCRETE

1. Complete finishing operations and allow visible surface water to dissipate prior to application of MasterKure® HD 100WB.
2. Surface must be able to bear foot traffic without marring or damaging the concrete.

NEWLY CURED BARE CONCRETE

1. Where concrete has not been membrane-cured, perform after-construction cleanup.
2. Level any areas gouged by trades and follow general cleanup instructions.

AGED CONCRETE OR NON-RESINOUS TERRAZZO

1. Mechanically remove aged membranes.
2. Patch, grout and fill cracks as necessary to restore the surface finish.
3. Follow general cleanup instructions.

VERTICAL WORK

1. After form stripping, repair and refine surface to meet project requirements. Remove remaining traces of parting compounds.
2. Ensure that surface is clean and free of surface moisture.

APPLICATION

1. Apply MasterKure HD 100WB by brush, squeegee, or hand sprayer. Spray application produces the best results.
2. Always apply to form a continuous, uniform film over the surface. Brush out any accumulations of excess material immediately.
3. One coat will typically produce a light-duty surface. Surface wearability increases with each additional application. Coverage is influenced by surface conditions and porosity, as well as job requirements. Refer to the yield chart.
4. It is the responsibility of the user to adjust the curing rate to properly regulate the hydration of the concrete. Two applications may be required. The rates given are approximate, assuming average concrete finish, temperature, and admixture used.
5. Each application must be thoroughly dry before the next is applied (See Drying Time).
6. When used as a curing aid, apply to edges after forms are removed.

CLEAN UP

Clean all tools and equipment with water immediately after use. Thoroughly flush sprayers. Dispose of unused material according to local regulations.

DRYING TIME

1. MasterKure HD 100WB penetrates in approximately 30-60 minutes per application, depending on temperature, humidity and job conditions. Each application must penetrate thoroughly before proceeding with the next.
2. MasterKure HD 100WB must completely dry before accepting any traffic. Allow 24 hours before subjecting to heavy traffic.

FOR BEST PERFORMANCE

- If MasterKure HD 100WB freezes, warm and restir to uniformity. If separation is persistent, discard product and do not use.
- When transferring MasterKure HD 100WB from the original sealed container, use only plastic buckets or pails.
- Do not apply MasterKure HD 100WB to floors that have been previously sealed or treated with curing and parting compounds unless these products have been chemically or mechanically removed.
- Do not apply MasterKure HD 100WB to resin-based terrazzo mixes.
- MasterKure HD 100WB will not remediate honeycombed or structurally unsound surfaces.
- Do not allow MasterKure HD 100WB to dry on terrazzo floors except as indicated in application instructions.
- Do not allow MasterKure HD 100WB to come in contact with any glass, fabric, metal, or painted surfaces. Immediately wipe contaminated surfaces with a clean water-saturated cloth, then wipe dry with a second clean cloth.
- For subsequent coating applications, consult coating manufacturer for surface preparation and application instructions.
- For professional use only; not for sale to or use by the general public.
- Make certain the most current versions of product data sheet and SDS are being used; call Customer Service (1-800-433-9517) to verify the most current versions.
- Proper application is the responsibility of the user. Field visits by BASF personnel are for the purpose of making technical recommendations only and not for supervising or providing quality control on the jobsite.

Technical Data

MasterKure HD 100WB is sodium-silicate-based.

Compliances

- USDA compliant for use in meat and poultry areas

Yield

Approximate ft²/gal (m²/L) per coat

	ROUGH FINISH	FINELY TEXTURED	WELL TROWELED
Newly Placed Concrete	300 (7.4)	400 (9.8)	500 (12.3)
Newly Cured Bare Concrete	200 (4.9)	300 (7.4)	400 (9.8)
Aged Concrete	150 (3.7)	200 (4.9)	250 (6.2)
Vertical Work	—	200 (4.9)	300 (7.4)

For best results for succeeding coats, increase coverage rate for each succeeding coat. Coverage varies with application method and the texture and porosity of the surface.

HEALTH, SAFETY AND ENVIRONMENTAL

Read, understand and follow all Safety Data Sheets and product label information for this product prior to use. The SDS can be obtained by visiting buildingsystems.basf.com, e-mailing your request to basfbcst@basf.com or calling 1(800)433-9517. Use only as directed.

**For medical emergencies only,
call ChemTrec® 1(800)424-9300.**

LIMITED WARRANTY NOTICE

BASF warrants this product to be free from manufacturing defects and to meet the technical properties on the current Technical Data Guide, if used as directed within shelf life. Satisfactory results depend not only on quality products but also upon many factors beyond our control. BASF MAKES NO OTHER WARRANTY OR GUARANTEE, EXPRESS OR IMPLIED, INCLUDING WARRANTIES OF MERCHANTABILITY OR FITNESS FOR A PARTICULAR PURPOSE WITH RESPECT TO ITS PRODUCTS. The sole and exclusive remedy of Purchaser for any claim concerning this product, including but not limited to, claims alleging breach of warranty, negligence, strict liability or otherwise, is the replacement of product or refund of the purchase price, at the sole option of BASF. Any claims concerning this product must be received in writing within one (1) year from the date of shipment and any claims not presented within that period are waived by Purchaser. BASF WILL NOT BE RESPONSIBLE FOR ANY SPECIAL, INCIDENTAL, CONSEQUENTIAL (INCLUDING LOST PROFITS) OR PUNITIVE DAMAGES OF ANY KIND.

Purchaser must determine the suitability of the products for the intended use and assumes all risks and liabilities in connection therewith. This information and all further technical advice are based on BASF's present knowledge and experience. However, BASF assumes no liability for providing such information and advice including the extent to which such information and advice may relate to existing third party intellectual property rights, especially patent rights, nor shall any legal relationship be created by or arise from the provision of such information and advice. BASF reserves the right to make any changes according to technological progress or further developments. The Purchaser of the Product(s) must test the product(s) for suitability for the intended application and purpose before proceeding with a full application of the product(s). Performance of the product described herein should be verified by testing and carried out by qualified experts.

Ian Buckley

Subject: FW: MasterKure HD 100 WB
Attachments: basf-masterkure-hd-100wb-tds.pdf

From: Jason E Theis [<mailto:jason.theis@basf.com>] **On Behalf Of** BLDGSYSSTECHSUPPORT
Sent: Friday, May 25, 2018 12:40 PM
To: James Angevine <James.Angevine@arup.com>
Cc: BLDGSYSSTECHSUPPORT <BLDGSYSSTECHSUPPORT@basf.com>
Subject: MasterKure HD 100 WB

Hi James,

Please be advised that Shotcrete is an acceptable substrate for use with the MasterKure HD 100WB.

See the attached Technical Data Guide for additional application information...

Thanks,

BASF Construction Systems Technical Support
BASF Corporation
889 Valley Park Drive
Shakopee, MN 55379

800-243-6739

www.master-builders-solutions.basf.us

Attachment 2: Data Sheet for Curecrete – Ashford Formula

**ASHFORD
FORMULA™**

THE ORIGINAL
CONCRETE
DENSIFICATION
TECHNOLOGY

 **DENSIFY**



CLEMENTINE SORTING FACILITY
DELANO, CA, USA
by YOUNGLOVE CONSTRUCTION COMPANY

*Think concrete's tough?
We make it tougher.*

ashfordformula.com

801.489.5663 / 800.998.5664



BENEFITS

Ashford Formula is a chemically reactive liquid that penetrates the concrete, solidifying the concrete surface components into a solid mass. It produces a permanently denser, harder, penetration and abrasion-resistant concrete surface. Ashford Formula is **inorganic, non-toxic, VOC free, colorless and odorless.**



DENSIFIES

Ashford Formula densifies concrete surfaces into a **solid mass** by penetrating the concrete and chemically filling the pores from within.



ABRASION RESISTANCE

Ashford Formula chemically hardens the concrete surface, increasing the **abrasion resistance by 32%**.



DUSTPROOFS

Ashford Formula **combines with calcium hydroxide**, becoming an integral part of the concrete, thus completely dustproofing the surface. This **reduces maintenance costs** and protects inventory and equipment from concrete dust.



CURES

Ashford Formula reacts immediately, chemically **stabilizing the finished concrete surface**. It also **accelerates and enhances hydration of the portland cement**, helping the concrete reach its design properties.



PERMANENT SHEEN

Over time, Ashford Formula treated floors develop a wax-like sheen. As a floor is subjected to traffic and regular cleaning, the machine-troweled concrete **self-polishes**, instead of eroding or wearing away.



ELIMINATES HIGH MAINTENANCE COSTS

Application of the Ashford Formula is a one-time, permanent application. This **eliminates the need for expensive re-application materials, labor costs and facility downtime**. Routine surface cleaning is all that is required for long-term maintenance.

DENSIFY FOR STRONGER, TOUGHER CONCRETE FLOORS

For years, concrete floors were protected with films and coatings - merely temporary solutions which wear away and require re-application. Ashford Formula takes a different approach by penetrating the concrete surface, growing crystals in the concrete itself. This reaction fills the natural pores and voids in the concrete, densifying the surface internally.



NON-DENSIFIED CONCRETE

A simple scratch test with a metal object demonstrates the softness of non-densified concrete.



This non-densified concrete sample reveals the porous structure of concrete, which leads to wear and deterioration.



ASHFORD FORMULA DENSIFIED CONCRETE

Scratching a concrete surface densified with Ashford Formula reveals no erosion or dusting. Ashford Formula has strengthened the concrete surface from within.



Ashford Formula densifies by penetrating the concrete surface and filling the natural pores and voids with crystalline growth.



HYUNDAI
NOŠOVICE, CZECH REPUBLIC
by eMZet s.r.o.
2008

THE RIGHT DECISION NOW, AND FOR THE FUTURE

There are so many choices and so many reasons, but the decision is simple. An Ashford Formula treated floor simply out-performs the competition in results and long-term cost savings, with an economical one-time investment. Properly densifying your floor means doing the job right the first time for results that last a lifetime.

SUBSTANTIAL COST SAVINGS

- ▶ Proven long-term performance at minimal cost
- ▶ Single, permanent application - no need for expensive re-application materials, labor or costly facility downtime
- ▶ Quick application - saves valuable construction time and cost
- ▶ Eliminates high maintenance costs - only routine cleaning is required for optimum results

REDUCED ENVIRONMENTAL IMPACT

- ▶ Use of existing concrete floors as the finished surface
- ▶ Permanent life cycle - no need for replacement like floor coverings
- ▶ Produces no fumes, vapors, off-gassing; VOC free - improves indoor air quality
- ▶ Contributes to LEED points for sustainable building; HPD available
- ▶ Packaged in re-conditioned blue drums

CERTIFICATIONS & RECOGNITIONS

- ▶ TÜV SÜD TM 14 Tested and Certified
- ▶ Zero (0) VOCs
- ▶ CE Declaration of Conformity
- ▶ REACH Certified
- ▶ NFSI Certified "High-Traction"
- ▶ Approved for use in food handling facilities



“ I AM CONVINCED THAT THE ASHFORD FORMULA IS THE ONLY WAY TO GO, AND I DON'T HESITATE TO GIVE THE FORMULA AN UNQUALIFIED RECOMMENDATION. ”

J. Keith McCoy, Chief of Maintenance, Pennzoil Company



PENNZOIL EXECUTIVE HANGAR
HOUSTON, TX, USA
1980



1



2



3



4

REAL PROJECT HIGHLIGHTS ▼

1 Inland Port 15 Warehouse
by Admire Concrete - USA

4 Parking Garage
by Wuxi Hua Can Chemical - CHINA

7 Melbourne Market Relocation
by Green Concrete Products - AUSTRALIA

2 Ozeaneum Museum
by NORSA GmbH - GERMANY

5 Metro Cash and Carry
by Gia Phu Dinh Construction - VIETNAM

8 Fairfax County Maintenance Repair Garage
by Mid-Atlantic Coatings, Inc. - USA

3 Ajans Medya Office
by ERA Ltd. - TURKEY

6 Daechun Harbor
by ILDO Trading Co. Ltd. - SOUTH KOREA

INDUSTRIES SERVED ▼

- > Correctional Facilities
- > Exhibit Halls
- > Parking Decks / Garages
- > Warehouses
- > Data Centers
- > Manufacturing Plants
- > Retail Stores
- > Stadiums / Sports Arenas
- > Distribution Centers
- > Outdoor Concrete

Note: This is not a comprehensive list. Ashford Formula and Curecrete's line of supporting products can be used on most any concrete floor serving a multitude of industries and functions.



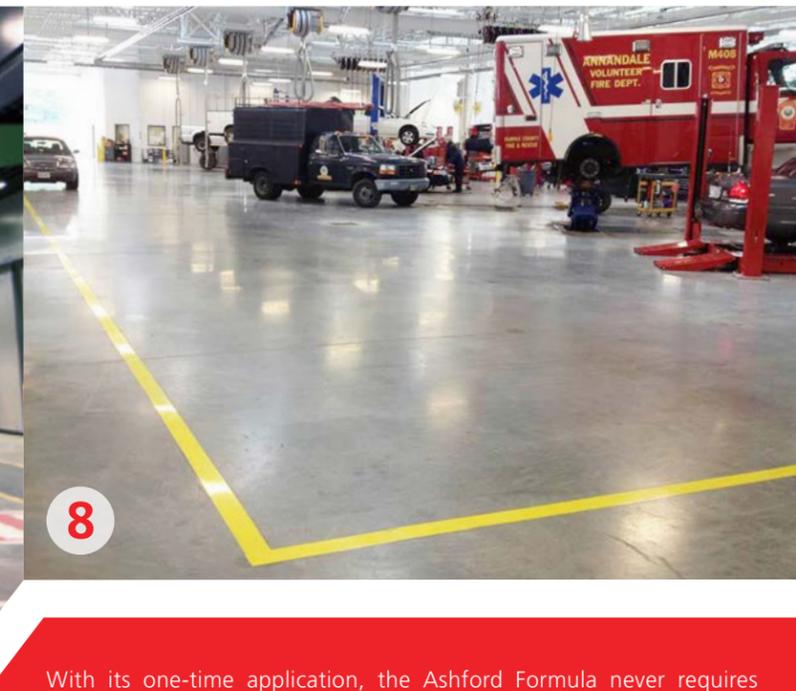
5



6



7



8

REAL PROJECTS

A SOLID FOUNDATION, FROM THE GROUND UP

Your business productivity requires a solid, **DENSIFIED** concrete floor.

Your concrete floor is more than a building foundation. It is also the foundation of your business productivity. For lifelong floor performance, long-term cost effectiveness and sustainability, worldwide corporations like Caterpillar, CocaCola, DHL, Procter & Gamble, IKEA and Whirlpool have chosen Ashford Formula as their concrete densifier of choice.

With its one-time application, the Ashford Formula never requires re-treatment. It provides exceptional performance for the entire life of your floor. Never halt your business productivity or pay for costly repeated applications down the road. It's why notable worldwide corporations have chosen the performance of the Ashford Formula.

With the longest proven track record of performance in the industry, 65+ years and counting, Ashford Formula is the trusted product for permanent, superior concrete floor results.

TECHNICAL DATA

PRODUCT INFO



SHUIDENG MACHINERY COMPANY
WUXI JIANGSU, CHINA
by WUXI HUA CAN CHEMICAL
2006

DESCRIPTION

Clear, odorless, non-toxic, non-combustible, non-flammable. Contains no VOCs.

USES

Concrete, heavyweight concrete block, exposed aggregate and other sand/aggregate portland cement combinations.

New or old concrete, rough or smooth surfaces.

FUNCTIONS

Densifies, dustproofs, hardens and cures. Protects against dusting, pitting, spalling, efflorescence and surface crazing. Inhibits freeze/thaw deterioration.

PACKAGING

- 55 - gallon drums / 208 liters
- 5 - gallon pails / 19 liters

STORAGE LIFE

Indefinite. Agitate before use.

COVERAGE

Approximately 200 ft²/gal (5 m²/L).

Coverage may depend on the temperature and porosity of the concrete.

TEMPERATURE LIMITS

Apply in temperatures up to 115°F (46°C) or as low as 35°F (1.7°C) and protect from freezing for a period of six (6) days.

SURFACE PREPARATION

- Freshly Finished Concrete (NEW): No preparation required.
- Existing Concrete (OLD): Sweep, scrub or strip concrete to remove any surface contaminants or film.

APPLICATION

Only one permanent application is required. Apply with high-volume, low-pressure sprayer until flood coat is achieved. Work material into the surface with fine-bristled brooms, or with an auto scrubber. Keep the entire surface wet with Ashford Formula for 30 minutes. Then when the Ashford Formula becomes slippery, flush completely with water and squeegee dry or vacuum excess with an automatic scrubber.

*See *Spec Data Sheet* or *Application Specifications* for specific details.

DRYING TIME

One (1) to three (3) hours. The surface may be used as soon as the application is complete and the surface is dry to the touch. Newly placed concrete requires the normal hardening period.

SURFACE APPEARANCE

On smooth troweled concrete, a sheen develops within 4-12 months. All other surfaces retain their natural appearance. The sheen can be accelerated by burnishing the floor. A spiff coat can also be used to enhance the initial sheen.

EQUIPMENT CLEAN-UP

Use soap and water before the Ashford Formula dries.

PAINTING

Allow at least seven (7) drying days before applying paint on existing concrete.

Allow twenty-eight (28) days for proper curing before painting new concrete.

NOTES

Apply to colored concrete only after the slab is fully cured, unless installed by a factory certified applicator.

Do not allow to dry on finished surfaces (glass, aluminum, stainless steel, walls, etc.) as permanent etching may occur.

The Ashford Formula may not prevent deterioration of floor slabs on which salts from ice melt are allowed to accumulate, especially when the floor is exposed to frequent wet/dry cycles.

Although the Ashford Formula provides a dense concrete surface, it cannot in all cases prevent the migration of moisture vapor from beneath a floor slab. In conditions of high vapor drive, salts and other inorganics may still be deposited on concrete floor surfaces treated with the Ashford Formula, especially when no vapor barrier has been installed beneath the slab.

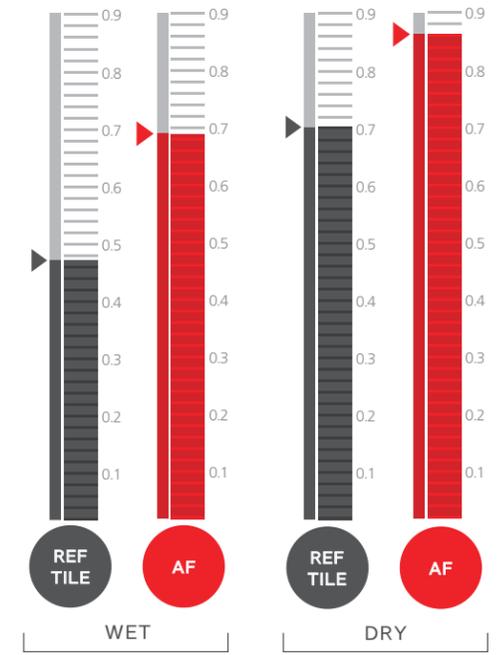
*Ashford Formula is a highly effective compound which delivers superior results. Application should be performed by qualified contractors with a clear understanding of its application and uses. *See **Spec Data Sheet** or **Application Specifications** for specific details.*



INCREASED ABRASION RESISTANCE

ASTM C 779 - Depth of Wear

Abrasion Resistance to Revolving Disks: An improvement of 32.5% over untreated samples after 30 minutes.



BONDING

ASTM D 3359 - Surface Adhesion

Adhesion of Coatings: For epoxy, a 22% increase in adhesion over untreated samples. No change in adhesion for polyurethane.

PERMEABILITY

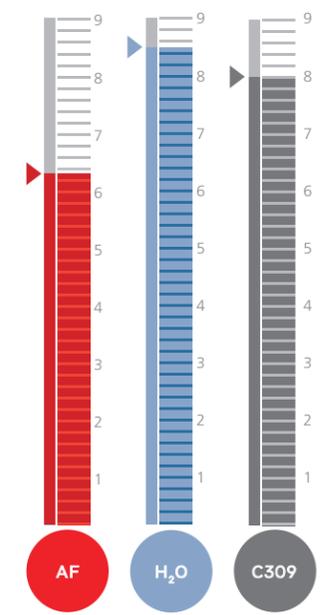
Seepage Rate

Using a 7 ft. (2.13 m) head of water on a 4.91 in² (124.71 mm²) area treated with Ashford Formula only allowed a rate of 0.00073 oz (0.022 cc) / hour. After several days the sample became damp, but no observable local seepage.

HIGHER FRICTION

ASTM C 1028 - Friction

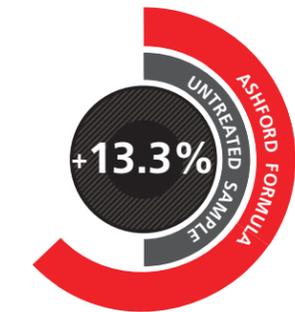
The co-efficient of friction on steel-troweled samples: reference tile vs. Ashford Formula (a higher ratio represents a less slippery surface): Wet - 0.69 vs. 0.47 // Dry - 0.86 vs. 0.71



ENHANCED CURING

ASTM C 856 - Petrographic Examination (Density of the Paste)

The number of unhydrated cement grains remaining on the surface - depth of 150 - 250 μm. Fewer unhydrated cement grains mean better curing.



GREATER IMPACT RESISTANCE

ASTM C 805 - Rebound Number

Impact Resistance by Schmidt Hammer: An increase of 13.3% over untreated samples.

WEATHERING

ASTM G 23 - Light Exposure Degradation

Exposure to ultraviolet light and water: No evidence of adverse effects on the samples treated with Ashford Formula.

This technical information is provided as a general performance profile for evaluating the appropriate use of Ashford Formula. Independent laboratories obtained the test performance results under controlled environments. Curecrete Distribution, Inc. makes no claim that these tests, or any other tests, accurately represent actual design and/or usage environments.

QUICK LINKS

APPLICATION SPECS



HPD



MANU SPEC



SAFETY DATA SHEET (SDS)



SPEC DATA



MAINTENANCE

PROPER MAINTENANCE
OPTIMAL PERFORMANCE
...for a lifetime.

MAINTENANCE PROGRAM

An effective maintenance program that includes routine scrubbing with stiff bristle brushes, ample down pressure, and proper amounts of water and detergent will enhance the floor's performance significantly. Implementation of the following maintenance program will allow the Ashford Formula to continue to react with the concrete, lifting contaminants away from the concrete and allowing the marble-like sheen to develop.

Scrub Floor OFTEN: Minimum routine cleaning 2 - 3 times per week with *CreteClean Plus with Scar Guard* provides superior results.

Clean Spills QUICKLY: After densification is complete, concrete will resist contamination and moisture penetration of most liquids. Corrosive or aggressively staining contaminants should be removed quickly to avoid possible staining.

RECOMMENDED SUPPLIES

> Automatic Scrubber

Capable of 125 - 150 lbs. of downward pressure.

> Black Stripping Pads or Medium-Aggressive Nylon Brushes

Accelerates the sheen and creates a more uniform appearance.

> Detergent*: *CreteClean Plus with Scar Guard*™

Performance enhancing detergent specifically designed to clean densified and densified-polished concrete floors. Regular use helps decrease the visibility of minor scratches and blemishes and helps maintain the concrete sheen.

> Large Volumes of Water

Water used while cleaning the concrete surface will actually accelerate the reaction between Ashford Formula and the concrete.

> Oil Emulsifier & Acrylic Stripper: *CreteStrip*™

Use directly on stain for spot treatment.

> Polypropylene or Stiff-Poly Brushes

Regular maintenance after sheen develops.

**If other detergents are used they should be non-acidic and void of hydroxides and sulfates.*

RECOMMENDED PRODUCTS

DETERGENT:



- 5 gal. (19 L) pails
- 55 gal. (208 L) drums



- Single dose packaging for auto scrubbers and mop and bucket cleaning

OIL EMULSIFIER,
& ACRYLIC
STRIPPER:



- 5 gal. (19 L) pails
- 55 gal. (208 L) drums

CASE STUDY: NORTH POINT TOYOTA

The use of truck soap had caused this floor to have a dull appearance. After a proper maintenance program was implemented, the natural sheen from the Ashford Formula was once again visible.

NORTH POINT TOYOTA
LITTLE ROCK, AR, USA
by ROBERTS-MCNUTT, INC.
2007



TBC DISTRIBUTION
SUMMERVILLE, SC, USA
by JOBSTASTERS, INC.
2010

Photo Credit: Leslie Burden. Reprinted with permission from the Charleston Regional Business Journal.

The TRUTH is...

*How you treat your floor now, determines
how your floor will treat you down the road.*

LIFELONG, OPTIMAL PERFORMANCE

Cleaning your Ashford Formula floor is convenient, economical and will result in a floor that has a marble-like sheen that improves with age. With Ashford Formula, there is no surface film or coating present to peel, blister or require expensive replacement and repeated applications. The floor's performance, as well as the satin sheen that develops over time, is enhanced by proper cleaning and maintenance. Following a proper maintenance program as outlined here will ensure optimal floor performance for a lifetime.

EXPECTATIONS FROM A PROPERLY MAINTAINED FLOOR

IMMEDIATELY AFTER TREATMENT

- ▶ The hardening and dustproofing will take effect within the normal curing period on new concrete and within 24-48 hours on existing concrete. The floor will have a normal concrete appearance or a slight sheen (broom-finished or rough-textured concrete will retain its natural concrete appearance).
- ▶ The density and hardness of the floor will be immediately enhanced. However, care should be taken not to gouge the floor with nails, etc. after the initial placement.
- ▶ To accelerate the sheen, the floor can be burnished with a high speed propane burnisher and a black stripping pad at 1800 to 3000 RPMs, or cleaned daily using an auto-scrubber equipped with medium-aggressive nylon brushes. A spiff coat can also be done to enhance the initial sheen.

3-6 MONTHS AFTER TREATMENT

- ▶ If the standard maintenance program is followed, smooth-troweled floor surfaces will develop a sheen.
Note: A sheen will not develop on floors with an open, porous finish, or on floors with a broom finish.
- ▶ On steel-troweled floors, water typically begins to bead on the surface.

12 MONTHS AFTER TREATMENT

- ▶ A hard shell-finished surface will develop.
- ▶ Surface is resistant to oil penetration and moisture contamination.

ONE COMPLETE SYSTEM



See how our "One Complete System" of concrete floor products works together to enhance the performance of your concrete floors.



ONE COMPLETE SYSTEM FOR ALL YOUR DENSIFIED AND DENSIFIED-POLISHED CONCRETE FLOORING NEEDS

Product availability varies by market. Contact your local representative.

ONE EXPERT SOURCE



QUALITY

A quality floor, paired with quality products, equals superior flooring results. Let our products take your floor to the next level.

PERFORMANCE

From start to "finish," our One Complete System of concrete floor products outperforms the competition and will enhance your concrete floors' performance durability, longevity and appearance.

VALUE

Your floors, done right, and done once, will save you time and money in the long term. Products that don't perform, and which require repeat applications, hamper your business' productivity and bottom line.

65+ YEARS OF LIVING PROOF THAT ABSOLUTELY CAN'T BE DISPUTED

Whether old or new concrete, our products will enhance your floor's performance, ensuring its durability and longevity for a lifetime.

THE DIFFERENCE

"GREEN" BY DESIGN FROM THE VERY BEGINNING

The Ashford Formula and the concept of concrete densification was "green" well before going "green" ever became a movement. The permanent effects of this unique combination will save significant time, money and energy in the long term.

The Ashford Formula's green qualities make it an exceptional choice for today's sustainable and green building initiatives. It has been widely specified for use on projects that have garnered LEED Certified, LEED Silver, LEED Gold and LEED Platinum status.



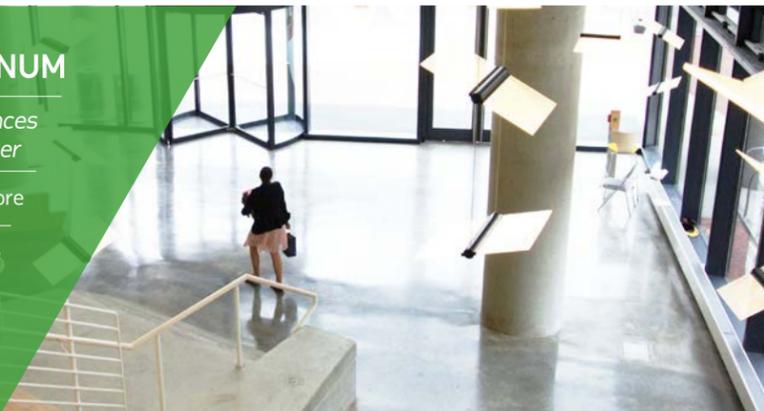
LEED PLATINUM

The John and Frances Angelos Law Center

University of Baltimore

by Cuviglio Concrete

2012



SUSTAINABILITY BENEFITS

- 1 Energy Cost Savings
- 2 Reduce Life Cycle Impacts
- 3 No Off-Gassing
- 4 Improved Thermal Comfort
- 5 Increased Daylighting; Light Reflection

THE "ORIGINAL" CONCRETE DENSIFIER

Built in 1949, the Casa de Cadillac dealership in Sherman Oaks, CA, USA is one of the earliest documented floors treated with the Ashford Formula. This facility is on the California historical register. Still in use today, the concrete floor has provided more than six decades of continuous service and attests to the longevity and durability of the Ashford Formula.



1989



2009



As if 65+ years isn't proof enough of the Ashford Formula's enduring performance, Curecrete Distribution, Inc. offers a standard **20-Year Product Performance Warranty** on Ashford Formula floors, as well as a **Lifetime* Product Performance Warranty** - the longest warranty offered in the industry - when maintained with *CreteClean Plus with Scar Guard™*.

*Qualifying conditions apply.

CURECRETE - SETTING THE STANDARD, RAISING THE BAR

Curecrete Distribution, Inc. has been providing leadership in the concrete densification industry for more than 65 years. Curecrete continues to lead with an unwavering commitment to superior products, best practices and industry expertise.



CURECRETE DISTRIBUTION, INC.

CONTACT ▶ 1203 Spring Creek Place
Springville, UT 84663, USA
(801) 489-5663
(800) 998-5664
www.ashfordformula.com
www.curecrete.com

TECHNICAL INFO ▶ (801) 489-5663
(800) 998-5664
techsupport@ashfordformula.com

CUSTOMER SERVICE ▶ (801) 489-5663
(800) 998-5664
customercare@curecrete.com

REPRESENTATIVES & INTERNATIONAL DISTRIBUTORS ▶ *Ashford Formula is sold through a network of manufacturer representatives and international distributors. To contact your representative or distributor, please visit:*
www.ashfordformula.com/ reps



NEUBAU LOGISTIKZENTRUM REWE
KÖLN-LANGEL, GERMANY
by NORSÄ GmbH
2010

A SOLID FOUNDATION, FROM THE GROUND UP

*Because your business productivity requires a solid, **DENSIFIED** concrete floor.*

Ian Buckley

Subject: FW: Ashford Formula

From: Dave Hoyt [<mailto:Dave.Hoyt@ashfordformula.com>]

Sent: Friday, May 25, 2018 11:35 AM

To: James Angevine <James.Angevine@arup.com>

Subject: Ashford Formula

Mr. Angevine,

The Ashford Formula can be used on Portland cement based Shotcrete. We do recommend that no Shrinking Reducing Admixtures (SRA's) be used in the mix design. For additional information and limitations you can download our Spec Data sheet at the following link:

<http://ashfordformula.com/wp-content/uploads/Ashford-Formula-Spec-Data-Sheet.pdf>

Regards,

Dave Hoyt
Director of Technical Service
Curecrete Distribution, Inc.
1203 W Spring Creek Place
Springville, UT 84663 USA
801-489-5663
800-998-5664



Memorandum

Attachment 3: Surface Coverage Information

(Masterseal 345 Literature)

1 General

This document has been produced by BASF for the application of MASTERSEAL® 345, a spray applied waterproofing membrane for underground structures.

This Method Statement is generic, and should be adapted to local site conditions to suit specific requirements and actual conditions where appropriate.

2 Surface Requirements

2.1 General

Correct preparation of the surface before spraying is necessary for the following three main reasons:

- Achieving a continuous membrane
- Limiting the material consumption to a reasonable amount
- Avoiding water from puncturing the membrane or hindering the curing of the membrane

This is mainly done by achieving a smooth substrate surface and removing excessive water ingress points. These issues are mentioned in detail in the following sections.

2.2 Optimising the substrate surface roughness before the application of the membrane

MASTERSEAL® 345 may be applied to any surface which provides proper bonding and a continuous membrane. In order to achieve a continuous membrane it is necessary that the substrate surface has a degree of smoothness. This means that holes, edges and sharp angles need to be removed from the surface by a smoothing layer of mortar or sprayed concrete.

This does not necessarily imply the sprayed concrete surface has to be screeded or float finished. It is recommended to observe the following main guidelines when planning and conducting the sprayed concrete works prior to the application of MASTERSEAL® 345:

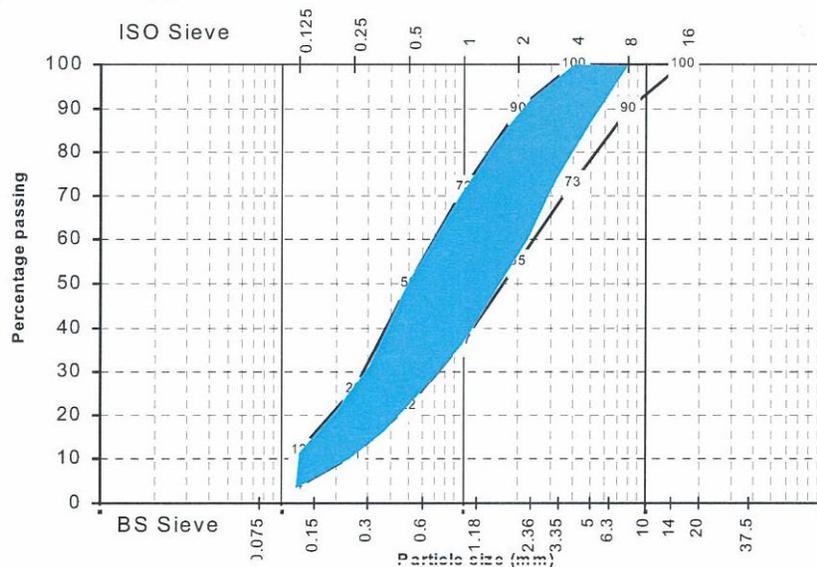


Figure 1: Combined grading for sprayed concrete

- Establish an optimal combined grading of the sprayed concrete aggregates. If possible choose a maximum aggregate size of between 4 and 8mm as indicated in Figure 1 (blue envelope).
- Ensure that you have the correct accelerator-cement combination that allows reasonable setting characteristics when sprayed. As demonstrated in Figure 2, poor setting will cause the sprayed concrete surface to be pitted or have large craters. This is not ideal for MASTERSEAL[®] 345 application.
- If you cannot get a suitable sprayed concrete surface with the primary sprayed concrete layer, then

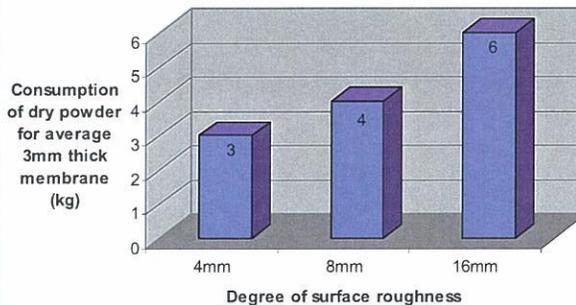
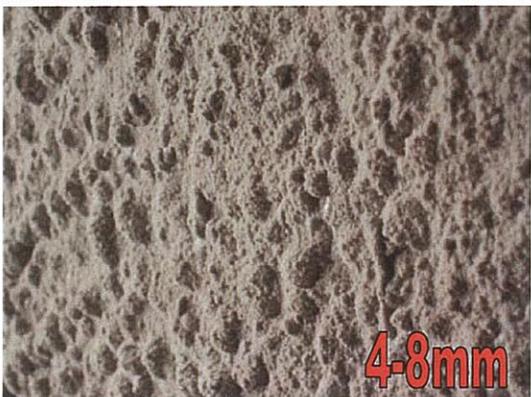
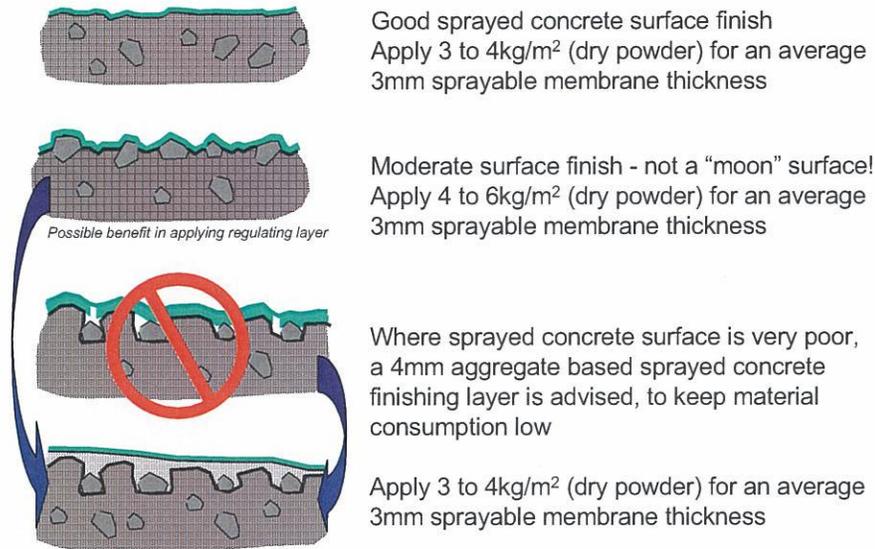


Figure 2: MASTERSEAL[®] 345 consumption depends on the surface

Memorandum

Attachment 4: Cost Analysis

Dustproofing Estimate
July 3, 2018

Estimate Items	Quantity	Unit	Material	Labor + quip	\$/SF - Direct	\$/SF - Total Cost	1.6 BASF		Ashford	
							Option 1: 4"	Option 2: 3+1	Option 1: 4"	Option 2: 3+1
Opt 1: Shotcrete Structural Layer 4"	219,481	SF	Shotcrete		\$ 6.04	\$ 9.66	\$ 2,120,643		\$ 2,120,643	
Opt 2: Shotcrete Structural Layer 3"	219,481	SF	Shotcrete	Shotcrete Crew	\$ 4.67	\$ 7.48		\$ 1,640,753		\$ 1,640,753
Opt 2: Shotcrete Fine Leveling Layer 1"	219,481	SF	Fine Shotcrete	Shotcrete Crew	\$ 1.56	\$ 2.49		\$ 546,918		\$ 546,918
Remove dust from chamber, wash walls	219,481	SF	Power Wash	Gen crew	\$ 0.25	\$ 0.40	\$ 87,792	\$ 87,792	\$ 87,792	\$ 87,792
BASF Walls: Opt 1	219,481	SF	BASF	low pressure, high volume sprayer	\$ 6.34	\$ 10.14	\$ 2,226,175			
BASF Walls: Opt 2	219,481	SF	BASF	low pressure, high volume sprayer	\$ 4.23	\$ 6.76		\$ 1,484,116		
BASF Floors	66,170	SF	BASF	low pressure, high volume sprayer	\$ 2.26	\$ 3.62	\$ 239,447	\$ 239,447		
Ashford Walls: Opt 1	219,481	SF	Ashford	low pressure, high volume sprayer	\$ 9.47	\$ 15.15			\$ 3,324,049	
Ashford Walls: Opt 2	219,481	SF	Ashford	low pressure, high volume sprayer	\$ 6.39	\$ 10.22				\$ 2,243,733
Ashford Floors	66,170	SF	Ashford	low pressure, high volume sprayer	\$ 2.29	\$ 3.66			\$ 242,270	\$ 242,270
Total Cost only +Layer Shotcrete, Clean, & Sealant							\$ 4,674,058	\$ 3,999,026	\$ 5,774,755	\$ 4,761,466
Avg S/SF	219,481	SF					\$ 21.30	\$ 18.22	\$ 26.31	\$ 21.69