

# Review report on sealing of shotcrete surfaces

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## Outline

- Background & purpose of study
- Arup preliminary report
- FRA's comments to Arup
- Path toward resolution



# Background and Purpose for Shotcrete Surface Study

- Subterranean shotcrete historically is a rough surface that lends to dusting due to the cementitious composition
- DUNE has concerns with excessive dusting and accumulation on detector components (ie racks). LBNF cryogenics has concerns as well with dust in the detector caverns and CUC.
- LBNF has researched different applications and costs to prevent shotcrete dusting (hand troweling, painting, polyurea sprayed coatings, etc.), but all were deemed cost prohibitive.
- Currently there is no science requirement for dust accumulation.
- DUNE requested CF to research low cost options into minimizing the amount of shotcrete dusting in the detector caverns and the CUC.
- FRA tasked Arup to research and provide a [Report](#) (docDB 9928) on solutions to mitigate dusting at the 4850L caverns.

# High Level Summary of Arup Shotcrete Surface Study

Arup's report on a high level covered the following:

- 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

# High Level Summary of Arup Shotcrete Surface Study

- The report focused strictly on utilizing a commercially available cementitious penetrating hardener/dustproofer (sodium silicate based) to be applied onto the shotcrete as well as concrete surfaces.
- The two products researched were:
  - BASF - MasterKure HD 100WB
  - Curecrete - Ashford Formula
- The two products researched were also analyzed under two different application scenarios:
  - Applied directly on rough surface of 4" shotcrete
  - Applied directly on smoother 1" fine leveling layer

# Proposed Products for Shotcrete Sealing



We create chemistry

Technical Data Guide

3 | 03 35 00  
Concrete  
Finishing

## MasterKure® HD 100WB & 100C

Concrete hardener and dustproof

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 dustproof 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

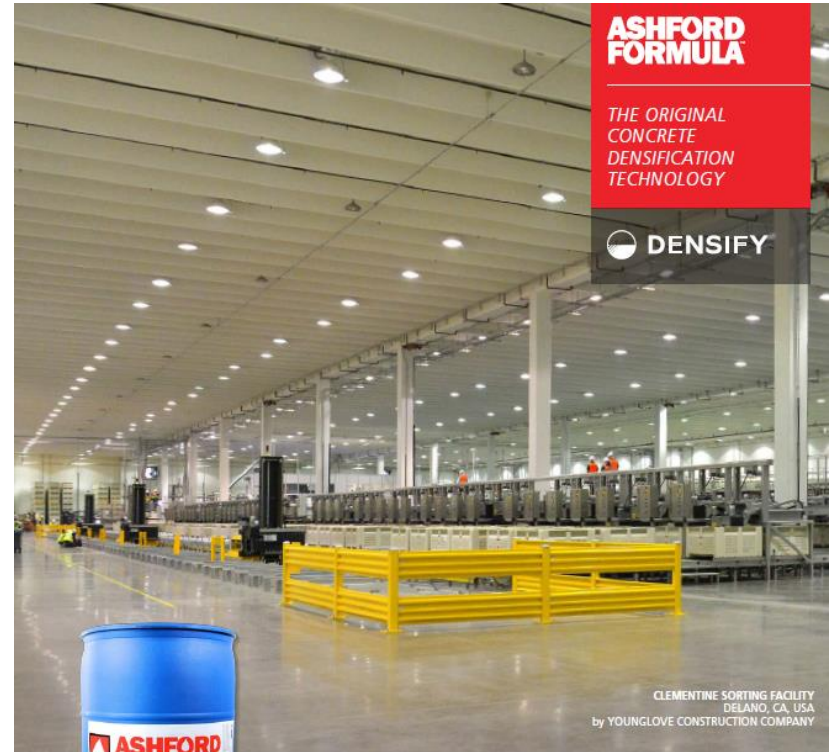
- Interior and exterior
- Floors and walls requiring a harder, easier-to-clean finish
- Docks and ramps

### SUBSTRATES

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

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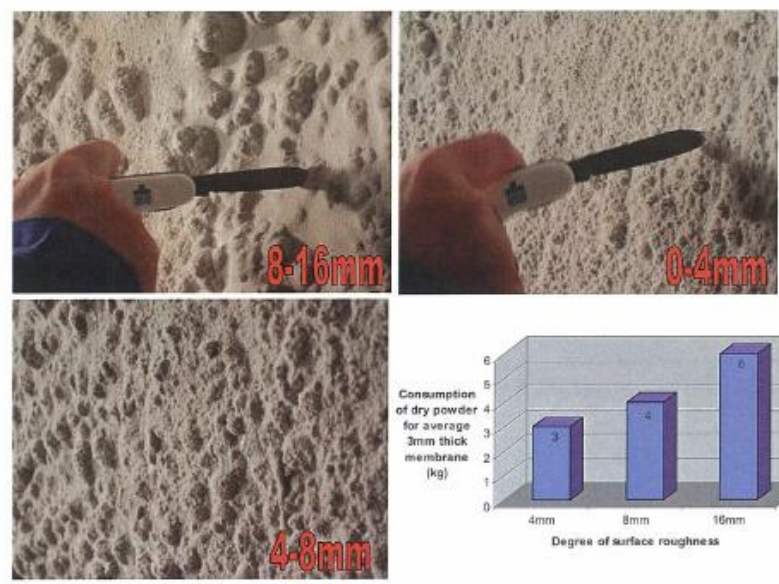
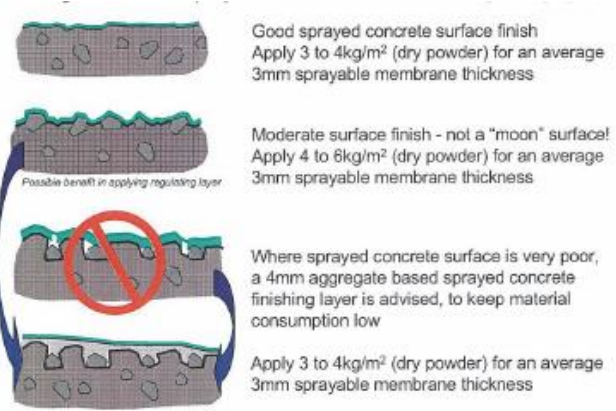


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# Shotcrete Surface Smoothness drives coverage rates and costs (SF/gallon)



# Preliminary Arup Cost Analysis

## 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
<b>Total Cost</b>	<b>\$4,674,058</b>	<b>\$3,999,026</b>	<b>\$5,774,755</b>	<b>\$4,761,466</b>
<b>Avg \$/SF</b>	<b>\$21</b>	<b>\$18</b>	<b>\$26</b>	<b>\$22</b>

Remove Shotcrete Cost	\$9.66/SF	\$9.97/SF	\$9.66/SF	\$9.97/SF
Sealant Only Cost	\$11.63/SF	\$8.25/SF	\$16.65/SF	\$11.72/SF



# Preliminary Cost Analysis

- Global assessment, 219,481 SF of surface @ \$8.25/SF =  
\$1,810,718 in Direct Costs
  - CM/GC OHP @ 9.5% \$1,720,018
  - CM/GC Bond @ 0.5% \$9,914
  - CM/GC Excise Tax @ 2.041% \$40,670
  - Total Cost in FY 2018 \$2,033,320
  - Escalation 4 years @ 3.5%/year \$284,665
  - Total Preliminary Cost in FY 2022 \$2,317,985
- That is approximately \$10.56/SF, so round up to \$11.00/SF based on preliminary information.

## FRA main comments on Arup Study

- Confirm any past history projects utilizing concrete hardeners/dustproofers on shotcrete. Contact shotcrete manufacturers and installers as well as sealing manufacturers.
- What are the potential interactions with shotcrete admixtures (eliminating shrinkage reducers, accelerators, etc.)?
- Was hand troweling evaluated at all?
- Was TSL (thin sprayed liners) evaluated at all?
- Arup is in the process of addressing the comments

## Path forward to a resolution

- Arup to provide response to FRA review comments
- Discuss the possibility of performing a test on existing shotcrete to verify dust reduction (ie sealing a section of Numi shotcrete)
- Discuss the possibility of performing a test section at SURF
- Receive a more defined science requirement for reducing dust
- Task KAJV with providing a cost estimate for the sodium silicate based penetrating hardener and 1” smoothing layer of shotcrete
- Discuss with stakeholders if \$2M+ additional cost is a benefit to the project.