

PRODUCT DATA SHEET

King[®] MS-D3

HIGH EARLY SHOTCRETE MATERIAL FOR DRY-MIX PROCESS APPLICATIONS



PRODUCT DESCRIPTION

King[®] MS-D3 is a high early strength, preblended, and pre-packaged shotcrete material formulated for dry-mix process applications. It contains high early Portland cement, silica fume, air-entraining admixture, blended aggregates, along with other carefully selected components. It has greatly enhanced shooting characteristics and physical properties, along with high early strength development.

USES

Overall:

- Rehabilitation of concrete bridges, dams, reservoirs, tunnels, marine structures, and parking ramps
- Lining and rehabilitation of sewers and watermains
- New construction including slope stabilization, soil-nailing, shaft and tunnel linings, pools and other concrete structures

Added Steel fiber reinforcement (ST) or

Added Macro-Synthetic fiber reinforcement (MF):

- Ground support applications for mining, tunneling, and other underground openings
- Rehabilitation of marine structures
- Lining and rehabilitation of sewers and other tunnels
- Slope stabilization, soil-nailing, shaft and tunnel linings

CHARACTERISTICS / ADVANTAGES

- Improved early age strength development
- Air-entrainment provides superior resistance to freeze-thaw cycling and salt-scaling resistance
- Improved adhesive and cohesive plastic properties

- Significantly reduced rebound, resulting in lower material usage
- Improved ability to build greater thicknesses in a single pass in both vertical and overhead orientations
- Improved resistance to water wash-out
- Improved resistance to sulphate attack
- Very low permeability
- Low shrinkage
- Compatible with integral, pre-applied and/or post-applied corrosion inhibitors
- Designed with natural normal-density non-reactive aggregates to eliminate potential alkali-aggregate reactivity (AAR)

OPTIONAL FEATURES & BENEFITS

Accelerator Level

- Improved performance in cold temperatures
- Improved performance in presence of running water
- Allows for earlier re-opening of traffic lanes on bridges and in subway tunnels

Product	Dosage Level
King [®] MS-D3	-
King [®] MS-D3 X	Level 1
King [®] MS-D3 X2	Level 2
King [®] MS-D3 X3	Level 3

Micro-Synthetic Fiber (SY)

- Micro-Synthetic fibers reduce cracking caused by intrinsic stresses
- Type III synthetic fiber in accordance with ASTM C1116
- Grade FR Class I shotcrete in accordance with ASTM C1480

Steel Fiber (ST)

- Improved performance in cold temperatures
- Improved performance in presence of running water
- Air-entrainment provides superior resistance to freeze-thaw cycling and salt-scaling resistance
- Significantly increased load carrying capacity
- Significantly increased energy absorbing capacity (toughness)
- Significantly increased impact resistance
- Improved adhesive and cohesive plastic properties
- Improved resistance to water wash-out
- Low permeability
- Reduction of cracking due to drying shrinkage

Product	Dosage of Fiber
King® MS-D3 STA	High
King® MS-D3 STB	Medium
King® MS-D3 STC	Low
King® MS-D3 STD	Very Low

Corrosion Inhibitor (CI)

- Corrosion inhibitor protects steel reinforcing and other metals embedded in concrete from corrosion induced by carbonation or chlorides
- Pre-blended corrosion inhibitor provides the correct dosage to enhance corrosion protection

Gradation

- By default King® MS-D3, King® MS-D3 MF, and King® MS-D3 ST are blended to meet ACI 506 “Guide to Shotcrete”, Table 1.1, Gradation No. 1 (No Added Abbreviation)
- King® MS-D3 G2, King® MS-D3 ST G2, and King® MS-D3 MF G2 are blended to meet ACI 506 “Guide to Shotcrete”, Table 1.1, Gradation No. 2 (G2)

Macro-Synthetic Fiber (MF)

- Improved performance in cold temperatures
- Improved performance in presence of running water
- Significantly decreased wear on placing equipment and accessories when compared with steel fibers
- Increased fire resistance
- Ideal for use in manways or other areas where people may come in contact with the shotcrete surface
- Significantly increased load carrying capacity
- Significantly increased energy absorbing capacity (toughness)
- Significantly increased impact resistance
- Low permeability
- Reduction of cracking due to drying shrinkage

Product	Dosage of Fiber
King® MS-D3 MFB	High
King® MS-D3 MFC	Medium
King® MS-D3 MFD	Low

EXAMPLES:

- For King® MS-D3 with a level 3 dosage of accelerator, with micro-synthetic fibers and gradation No. 2, the name of the product would be:
King® MS-D3 X3 SY G2.
- For King® MS-D3 ST with a high dosage of steel fiber, a level 2 dosage of accelerator and a gradation No. 1, the name of the product would be:
King® MS-D3 X2 STA.
- For King® MS-D3 MF with a level 2 dosage of accelerator, a high dosage of macro-synthetic fiber and gradation No. 1, the name of the product would be:
King® MS-D3 X2 MFB.

PRODUCT INFORMATION

Packaging	66 lb (30 kg) bag 2205 lb (1000 kg) FIBC* Products with Macro-Synthetic fibers (MF) or Steel fibers (ST) can only be packaged in FIBC* Custom packaging is available to suit specific project requirements <small>*Flexible Intermediate Bulk Container</small>
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Shelf Life	12 months in original, unopened packaging
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Storage Conditions	Store in a dry, covered area, protected from the elements between 40°F - 95°F (5°C - 35°C)
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Underground Environments

Physical properties may be adversely affected if material is stored in temperatures below 40°F (5°C) and should be allowed to warm to ambient underground temperatures before application

Product Data Sheet

King® MS-D3

April 2024, Version 06.02

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TECHNICAL INFORMATION

Compressive Strength

	ASTM C116 (MODIFIED)		
	King® MS-D3 X	King® MS-D3 X2	King® MS-D3 X3
4 Hours	-	290 psi (2 MPa)	1015 psi (7 MPa)
8 Hours	1015 psi (7 MPa)	1150 psi (8 MPa)	1500 psi (10 MPa)
12 Hours	1500 psi (10 MPa)	1750 psi (12 MPa)	2030 psi (14 MPa)

	ASTM C1604			
	King® MS-D3	King® MS-D3 X	King® MS-D3 X2	King® MS-D3 X3
1 Day	3000 psi (21 MPa)	3625 psi (25 MPa)	3625 psi (25 MPa)	3625 psi (25 MPa)
3 Day	4350 psi (30 MPa)	4350 psi (30 MPa)	4350 psi (30 MPa)	4350 psi (30 MPa)
7 Day	5075 psi (35 MPa)	5075 psi (35 MPa)	5075 psi (35 MPa)	5075 psi (35 MPa)
28 Day	6000 psi (42 MPa)	6000 psi (42 MPa)	6000 psi (42 MPa)	6000 psi (42 MPa)

Modulus of Elasticity in Compression

	ASTM C469
1 Day	3.0 x 10 ⁶ psi (20.8 GPa)
7 Days	3.2 x 10 ⁶ psi (22.0 GPa)
28 Days	3.7 x 10 ⁶ psi (25.4 GPa)

Flexural Strength

	ASTM C78			
	King® MS-D3	King® MS-D3 X	King® MS-D3 x2	King® MS-D3 X3
7 days	940 psi (6.5 MPa)	870 psi (6.0 MPa)	870 psi (6.0 MPa)	870 psi (6.0 MPa)
28 days	1085 psi (7.5 MPa)	1015 psi (7.0 MPa)	1015 psi (7.0 MPa)	1015 psi (7.0 MPa)

	King® MS-D3 ST & King® MS-D3 MF	ASTM C78
28 days		1160 psi (8.0 MPa)

King® MS-D3 MFB

Peak applied Toughness as a function of flexure load

	10 mm	20 mm	30 mm	40 mm
5620 lbf (25 kN)	> 150 J	> 250 J	> 350 J	> 450 J

King® MS-D3 MFC

Peak applied Toughness as a function of flexure load

	10 mm	20 mm	30 mm	40 mm
4495 lbf (20 kN)	> 80 J	> 125 J	> 250 J	> 350 J

King® MS-D3 MFD

Peak applied Toughness as a function of flexure load

	10 mm	20 mm	30 mm	40 mm
5620 lbf (25 kN)	> 50 J	> 80 J	> 150 J	> 275 J

STEEL FIBER

King® MS-D3 STA

Peak applied Toughness as a function of flexure load

	5 mm	10 mm	20 mm	30 mm	40 mm
8992 lbf (40 kN)	> 100 J	> 215 J	> 350 J	> 450 J	> 500 J

King® MS-D3 STB

Peak applied Toughness as a function of flexure load

	5 mm	10 mm	20 mm	30 mm	40 mm
5620 lbf (25 kN)	> 100 J	> 190 J	> 300 J	> 375 J	> 425 J

King® MS-D3 STC

Peak applied Toughness as a function of flexure load

	5 mm	10 mm	20 mm	30 mm	40 mm
4495 lbf (20 kN)	> 100 J	> 175 J	> 270 J	> 325 J	> 370 J

King® MS-D3 STD

Peak applied Toughness as a function of flexure load

	5 mm	10 mm	20 mm	30 mm	40 mm
4495 lbf (20 kN)	> 40 J	> 80 J	> 125 J	> 150 J	> 175 J

FLEXURAL PERFORMANCE			ASTM C1609		
Dosage	First peak strength	F ¹⁰⁰ ₆₀₀	F ¹⁰⁰ ₁₅₀		
King® MS-D3 STA	906 psi (6.25 MPa)	797 psi (5.50 MPa)	652 psi (4.50 MPa)		
King® MS-D3 STB	797 psi (5.50 MPa)	435 psi (3.00 MPa)	398 psi (2.75 MPa)		
King® MS-D3 STC	652 psi (4.50 MPa)	435 psi (3.00 MPa)	398 psi (2.75 MPa)		
King® MS-D3 STD	580 psi (4.00 MPa)	362 psi (2.50 MPa)	145 psi (1.00 MPa)		
Tensile Strength	TENSILE BOND STRENGTH		ASTM C1583		
	7 Days	320 psi (2.2 MPa)			
	28 Days	335 psi (2.3 MPa)			
Splitting tensile strength				ASTM C496	
	7 Day	640 psi (4.4 MPa)			
	28 Day	65 psi (4.6 MPa)			
Slant Shear Strength	BOND STRENGTH BY SLANT SHEAR (MODIFIED)			ASTM C882	
	7 Days	3060 psi (21.0 MPa)			
	28 Days	3625 psi (25.0 MPa)			
Shrinkage	UNIAXIAL DRYING SHRINKAGE				
		King® MS-D3	King® MS-D3 X	King® MS-D3 X2	King® MS-D3 X3
	28 Days	0.050 %	0.060 %	0.060 %	0.060 %
	56 Days	0.058 %	0.065 %	0.065 %	0.065 %
Coefficient of Thermal Expansion				CRD-C39	
	28 Days	4.5 x 10 ⁻⁶ /°F (8.1 x 10 ⁻⁶ /°C)			
Rapid Chloride Permeability	CHLORIDE ION PENETRABILITY			ASTM C1202	
	700 coulombs				
Porosity	AIR CONTENT				
	6% ± 2%				
	MAXIMUM AIR VOID SPACING FACTOR			ASTM C457	
	0.0118 in (300 µm)				
	BOILED ABSORPTION			ASTM C642	
	6.0%				
	MAXIMUM VOLUME OF PERMEABILITY VOIDS			ASTM C642	
	15.0%				
Freeze-Thaw Stability	ASTM C666				
	King® MS-D3	King® MS-D3 X	King® MS-D3 X2	King® MS-D3 X3	
	95%	95%	95%	88%	
Salt resistance	SALT-SCALING RESISTANCE			ASTM C672	
	King® MS-D3	King® MS-D3 X	King® MS-D3 X2	King® MS-D3 X3	
	0.02 lb/ft ² (0.10 kg/m ²)	0.035 lb/ft ² (0.17 kg/m ²)	0.04 lb/ft ² (0.20 kg/m ²)	0.24 lb/ft ² (1.2 kg/m ²)	

APPLICATION INFORMATION

Coverage

Approx. 0.5 ft³ per 66 lb bag (0.014 m³ per 30 kg bag)
 Approx. 16.5 ft³ per 2205 lb FIBC (0.45 m³ per 1000 kg FIBC)
 *May vary according to projects conditions

Set Time

ASTM C1117

	King® MS-D3	King® MS-D3 X	King® MS-D3 X2	King® MS-D3 X3
Initial	3 hours	45 minutes	15 minutes	3 minutes
Final	5 hours	60 minutes	25 minutes	5 minutes

BASIS OF PRODUCT DATA

Results may differ based upon statistical variations depending upon mixing methods and equipment, temperature, application methods, test methods, actual site conditions and curing conditions.

The following data was obtained under controlled conditions with material and ambient temperatures of 70 °F (21 °C) . Higher or lower temperatures can respectively accelerate or delay setting time and early-age compressive strength gain.

AVAILABILITY/WARRANTY

Each of the following descriptors / features have the possibility of being included in a specific mix design; Either on their own, or combined with any other descriptors / features.

Descriptors / Features of accelerator dosages:

Accelerator	X - Level 1
	X2 - Level 2
	X3 - Level 3

Descriptors / Features of fiber dosages:

Steel Fibers	STA - High
	STB - Medium
	STC - Low
	STD - Very Low
Micro-Synthetic Fibers	SY
Macro-Synthetic Fibers	MFB - High
	MFC - Medium
	MFD - Low

Descriptors / Features of other technologies:

Corrosion Inhibitor	CI
Anti-Microbial	AM
Crystalline Waterproofing	CW
10% Silica Fume	SF10
Not Air Entrained	NE
Gradation 2	G2

ENVIRONMENTAL, HEALTH AND SAFETY

For further information and advice regarding transportation, handling, storage and disposal of chemical products, user should refer to the actual Safety Data Sheets containing physical, environmental, toxicological and other safety related data. User must read the current actual Safety Data Sheets before using any products. In case of an emergency, call CHEMTREC at 1-800-424-9300, International 703-527-3887.

APPLICATION INSTRUCTIONS

EQUIPMENT

Special precautions needed when using predampeners with dry blended powdered accelerated shotcrete.

Contact your Sika STM Technical Representative in for more information.

SURFACE PREPARATION

Temperatures above 40 °F (5 °C):

- **Repair or Rehabilitation** : All surfaces to be in contact with King® MS-D3 and its variations must be free from dust, oil, grease or any other foreign substances that may interfere with the bond of the material. Remove all loose or delaminated concrete providing a roughened surface and a minimum of 20 mm (¾ inch) clearance behind any corroded reinforcing steel. The perimeter of the repair area should be sawcut a minimum of 20 mm (¾ inch). Clean the area to be repaired with potable water, leaving the concrete saturated but free of standing water (SSD).
- **Rock Surfaces** : All surfaces to be in contact with King® MS-D3 and its variations must be free from dust, oil, grease or any other foreign substances that may interfere with the bond of the material. Remove all loose or delaminated rock. Clean the area with potable water, leaving the substrate saturated but free of standing water (SSD).

Temperatures below 40 °F (5 °C):

Use King® MS-D3 (X2 / X2 MF / X2 ST)
or King® MS-D3 (X3 / X3 MF / X3 ST)

- **Repair or Rehabilitation:** All surfaces to be in contact with King® MS-D3 X2 or King® MS-D3 X3 must be free from oil, grease or any other foreign substances that may interfere with the bond of the material. Remove all loose or delaminated concrete providing a roughened surface and a minimum of 1 inch (25 mm) clearance behind the reinforcing steel. The perimeter of the repair area should be sawcut a minimum of ¾ inch (20 mm). To avoid freezing of the interface between the shotcrete and the parent concrete, do not pre-wet the receiving surface. Pneumatically remove any free standing or other fine particles that may interfere with the bond between King® MS-D3 X2 or King® MS-D3 X3 and the substrate. Do not apply King® MS-D3 X2 or King® MS-D3 X3 when ambient temperature is below or is expected to fall below 20 °F (-5 °C) within 6 hours following the application of shotcrete. Do not apply when temperature of receiving surface is below 20 °F (-5 °C). Material temperature should be maintained above 50 °F (10 °C) at the time of application. Mixing water temperature should be maintained between 70° F (20°C) and 80 °F (25 °C).
- **Rock Surfaces:** All surfaces to be in contact with King® MS-D3 X2 or King® MS-D3 X3 must be free from dust, oil, grease or any other foreign substances that may interfere with the bond of the material. Remove all loose or delaminated rock. To avoid freezing of the interface between the shotcrete and the parent concrete, do not pre-wet the receiving surface. Pneumatically remove any free standing or other fine particles that may interfere with the bond between King® MS-D3 X2 or King® MS-D3 X3 and the substrate.

APPLICATION

Apply in accordance with the ACI 506 "Guide to Shotcrete" publication.

Performance of in-place shotcrete relies heavily upon application techniques. The shotcrete material, equipment and key personnel should be pre-qualified prior to project start-up to ensure optimum quality of in-place shotcrete

OPTIMUM PERFORMANCE

- King® MS-D3, King® MS-D3 X, King® MS-D3 MF, King® MS-D3 X MF, King® MS-D3 ST, and King® MS-D3 X ST should not be applied when ambient, substrate, and material temperatures are below 40 °F (5 °C) or above 95 °F (35 °C).
- King® MS-D3 X2 and King® MS-D3 X3 should not be applied when ambient and substrate temperatures are below 20 °F (-5 °C) or when ambient, substrate and material temperatures are above 95 °F (35 °C).
- For adverse temperatures, follow ACI recommendations for Cold / Hot Weather Concreting.
- When using King® MS-D3 MF or King® MS-D3 ST, recommended minimum inside diameter of shotcrete hoses should be 2 inch (50 mm).

Contact your Sika STM a Technical Representative for more information.

CURING TREATMENT

Curing is essential to optimize physical properties of the shotcrete and minimize plastic shrinkage. Product should be cured immediately after material has reached initial set in accordance with ACI 308 "Guide to Curing Concrete". Continuously moist cure for a minimum period of 7 days. Alternatively, moist cure for a minimum period of 24 hours and apply a curing compound that complies with ASTM C 309. Curing is particularly critical in rapid moisture loss conditions such as high temperatures, high winds and low humidity.

Underground environments

Good curing conditions are beneficial to optimizing physical properties. Although the high relative humidity commonly found in underground environments provides for good curing conditions, additional curing is often appropriate and should be performed in accordance with ACI 308 "Guide to Curing Concrete".

For temperatures below 40 °F (5 °C):

A resin based liquid membrane curing compound approved for use in cold weather conditions should be applied immediately after shotcrete reaches final set be applied immediately after shotcrete reaches final set.

CLEANING OF TOOLS

Clean all tools and equipment after use with water. Once hardened, the product can only be removed mechanically.

OTHER RESTRICTIONS

See Legal Disclaimer.

LEGAL DISCLAIMER

- KEEP CONTAINER TIGHTLY CLOSED
- KEEP OUT OF REACH OF CHILDREN
- NOT FOR INTERNAL CONSUMPTION
- FOR INDUSTRIAL USE ONLY
- FOR PROFESSIONAL USE ONLY

Prior to each use of any product of Sika Corporation, its subsidiaries or affiliates ("SIKA"), the user must always read and follow the warnings and instructions on the product's most current product label, Product Data Sheet and Safety Data Sheet which are available at usa.sika.com or by calling SIKA's Technical Service Department at 1-800-933-7452. Nothing contained in any SIKA literature or materials relieves the user of the obligation to read and follow the warnings and instructions for each SIKA product as set forth in the current product label, Product Data Sheet and Safety Data Sheet prior to use of the SIKA product.

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Product Data Sheet

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