

PRODUCT DATA SHEET

King® MS-D3

HIGH EARLY SHOTCRETE MATERIAL FOR DRY-MIX PROCESS APPLICATIONS

PRODUCT DESCRIPTION

King® MS-D3 is a pre blended, pre-packaged, dry-process shotcrete material containing high early Portland cement, silica fume, air-entraining admixture, blended aggregates and other carefully selected components. It has greatly enhanced shooting characteristics and physical properties.

WHERE TO USE

Overall:

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

Included with steel fibre reinforced (ST) & Macro-synthetic fibre reinforced (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 of accelerator
King® MS-D3	-
King® MS-D3 X	level 1
King® MS-D3 X2	level 2
King® MS-D3 X3	level 3

MICRO-SYNTHETIC FIBRE (SY)

- Synthetic fibres reduce cracking caused by intrinsic stresses
- Type III synthetic fibre in accordance with ASTM C 1116
- Grade FR Class I shotcrete in accordance with ASTM C 1480

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

*For more information regarding the use of a corrosion inhibitor in conjunction with King® MS-D3, please contact your Sika Technical Representative.

MACRO-SYNTHETIC FIBRE (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 fibres
King® MS-D3 MFB	high
King® MS-D3 MFC	medium
King® MS-D3 MFD	low

STEEL FIBRE (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 fibres
King® MS-D3 STA	high
King® MS-D3 STB	medium
King® MS-D3 STC	low
King® MS-D3 STD	very low

EXAMPLES:

- For King® MS-D3 with a level 3 dosage of accelerator, with synthetic fibres 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 fibre, 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 fibre and Gradation No. 1, the name of the product would be King® MS-D3 X2 MFB.

APPROVALS / CERTIFICATES

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
- 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

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PRODUCT INFORMATION

Packaging

- 30 kg (66 lb) triple-lined bags
- 1 000 kg (2 205 lb) FIBC
- Products containing macro-synthetic fibres (MF) or steel fibres (ST) can only be packaged in bulk bags (FIBC).

**Custom packaging is available to suit specific project requirements*

Shelf Life

12 months in original, unopened packaging

Storage Conditions

Material should be stored in a dry, covered area, protected from the elements. For optimum performance it is recommended to store the material between 5°C (40°F) and 35°C (95°F) .

Underground environments

Physical properties may be adversely affected if material is stored in temperatures below 5°C (40°F), material stored below these temperatures should be allowed to warm to ambient underground temperatures before shooting. For optimum performance it is recommended to store the material between 5°C (40°F) and 35°C (95°F) .

TECHNICAL INFORMATION

Compressive Strength

ASTM C 116 (MODIFIED)

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

ASTM C 1604

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

Modulus of Elasticity in Compression

ASTM C 469

1 day	20.8 GPa (3.0 x 10 ⁶ psi)
7 days	22.0 GPa (3.2 x 10 ⁶ psi)
28 days	25.4 GPa (3.7 x 10 ⁶ psi)

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	King® MS-D3	King® MS-D3 X	King® MS-D3 x2	King® MS-D3 X3
7 days	6.5 MPa (940 psi)	6.0 MPa (870 psi)	6.0 MPa (870 psi)	6.0 MPa (870 psi)
28 days	7.5 MPa (1085 psi)	7.0 MPa (1015 psi)	7.0 MPa (1015 psi)	7.0 MPa (1015 psi)
King® MS-D3 ST & MF				
28 days	8.0 MPa (1160 psi)			

Flexural Rigidity

MACRO-SYNTHETIC FIBRE ASTM C 1550

King® MS-D3 MFB

Peak applied load Toughness as a function of flexure load

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

King® MS-D3 MFC

Peak applied load Toughness as a function of flexure load

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

King® MS-D3 MFD

Peak applied load Toughness as a function of flexure load

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

STEEL FIBRE

ASTM C 1550

King® MS-D3 STA

Peak applied load Toughness as a function of flexure load

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

King® MS-D3 STB

Peak applied load Toughness as a function of flexure load

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

King® MS-D3 STC

Peak applied load Toughness as a function of flexure load

	5 mm	10 mm	20 mm	30 mm	40 mm
20 kN (4496 lbf)	> 100J	> 175J	> 270J	> 325J	> 370J

King® MS-D3 STD

Peak applied load Toughness as a function of flexure load

	5 mm	10 mm	20 mm	30 mm	40 mm
20 kN (4496 lbf)	> 40J	> 80J	> 125J	> 150J	> 175J

FLEXURAL PERFORMANCE

ASTM C 1609

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Dosage	First peak strength	F ₁₀₀₆₀₀	F ₁₀₀₁₅₀
King® MS-D3 STA	6.25 MPa (906 psi)	5.50 MPa (797 psi)	4.50 MPa (652 psi)
King® MS-D3 STB	5.50 MPa (797 psi)	3.00 MPa (435 psi)	2.75 MPa (398 psi)
King® MS-D3 STC	4.50 MPa (652 psi)	3.00 MPa (435 psi)	2.75 MPa (398 psi)
King® MS-D3 STD	4.00 MPa (580 psi)	2.50 MPa (362 psi)	1.00 MPa (145 psi)

Tensile Strength	TENSILE BOND STRENGTH	ASTM C 1583
	7 Days	2.2 MPa (320 psi)
	28 Days	2.3 MPa (335 psi)

Splitting Tensile Strength		ASTM C 496
	7 days	4.4 MPa (640 psi)
	28 days	4.6 MPa (665 psi)

Shear Adhesion Strength	BOND STRENGTH BY SLANT SHEAR (MODIFIED)	ASTM C 882
	7 days	21.0 MPa (3060 psi)
	28 days	25.0 MPa (3625 psi)

Shrinkage	UNIAXIAL DRYING SHRINKAGE				ASTM C 157
	King® MS-D3	King® MS-D3 X	King® MS-D3 X2	King® MS-D3 X3	
	28 Days	500 µm/m	600 µm/m	600 µm/m	600 µm/m
	56 Days	580 µm/m	650 µm/m	650 µm/m	650 µm/m

Coefficient of Thermal Expansion	28 Days	8.1 x 10 ⁻⁶ / °C (4.5 x 10 ⁻⁶ / °F)	CRD-C 39
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Chloride Ion Diffusion Resistance	CHLORIDE ION PENETRABILITY	ASTM C 1202
	700 coulombs	

Porosity	AIR CONTENT	ASTM C 457
	6% ± 2%	
	MAXIMUM AIR VOID SPACING FACTOR	ASTM C 457
	300 µm	
	BOILED ABSORPTION	ASTM C 642
	6.0%	
MAXIMUM VOLUME OF PERMEABILITY VOIDS	ASTM C 642	
15.0%		

Freeze thaw resistance	King® MS-D3	King® MS-D3 X	King® MS-D3 X2	King® MS-D3 X3	ASTM C 666
	95%	95%	95%	88%	

Salt Resistance	SALT-SCALING RESISTANCE				ASTM C 672
	King® MS-D3	King® MS-D3 X	King® MS-D3 X2	King® MS-D3 X3	
	0.10 kg/m ² (0.02 lb/ft ²)	0.17 kg/m ² (0.035 lb/ft ²)	0.20 kg/m ² (0.04 lb/ft ²)	1.2 kg/m ² (0.24 lb/ft ²)	

APPLICATION INFORMATION

Yield	
	▪ Approx. 0.014 m ³ (0.5 ft ³) / 30 kg (66 lb) bag
	▪ Approx. 0.45 m ³ (16.5 ft ³) / 1,000 KG (2,205 lb) bag

Setting Time

ASTM C 1117

	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

All technical data stated in this Data Sheet are based on laboratory tests. Actual measured data may vary due to circumstances beyond our control.

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

OTHER DOCUMENTS

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 descriptor / feature:

Corrosion inhibitor (CI)	Anti-microbial (AM)	Crystalline Water-proofing (CW)
Gradation 2 (G2)	Not Air Entrained (NE)	10% Silica Fume (SF10)
Accelerator level 1 (X)	Accelerator level 2 (X2)	Accelerator level 3 (X3)

Descriptor / features of fibre dosages:

Steel fibre (ST)	STA, STB, STC, STD
Micro Synthetic (SY)	SY
Macro Synthetic (MF)	MFB, MFC, MFD

LIMITATIONS

- Use of a predampener in conjunction with dry-process, accelerated shotcrete is not recommended. Contact your local Sika Technical Representative for more information
- Performance of in-place shotcrete relies heavily upon application techniques. To ensure optimum quality of in-place shotcrete, the material, equipment and key personnel should be pre-qualified prior to project start-up.

ENVIRONMENT, HEALTH & SAFETY

User must read the most recent corresponding Safety Data Sheets (SDS) before using any products. The SDS provides information and advice on the safe handling, storage and disposal of chemical products and contains physical, ecological, toxicological and other safety-related data.

APPLICATION INSTRUCTIONS**SURFACE PREPARATION****TEMPERATURES ABOVE 5°C (40°F):**

- 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).
- 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).

TEMPERATURES BELOW 5°C (40°F)

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

- 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.
- 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

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that may interfere with the bond of the material. Remove all loose or delaminated concrete providing a roughened surface and a minimum of 25 mm (1 inch) clearance behind the reinforcing steel. The perimeter of the repair area should be sawcut a minimum of 20 mm (¾ inch). 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 -5 °C (20 °F) within 6 hours following the application of shotcrete. Do not apply when temperature of receiving surface is below -5 °C (20 °F). Material temperature should be maintained above 10 °C (50 °F) at the time of application. Mixing water temperature should be maintained between 20°C (70° F) and 25 °C (80 °F).

APPLICATION

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

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 5 °C (40 °F) or above 35 °C (95 °F).
- For adverse temperatures, follow ACI recommendations for Cold/Hot Weather Concreting.

TEMPERATURES BELOW 5°C (40°F) :

Do not apply King® MS-D3 X2 or King® MS-D3 X3 when ambient temperature is below or is expected to fall below -5 °C (20 °F) within 6 hours following the application of shotcrete.

Do not apply when temperature of receiving surface is below -5 °C (20 °F). Material temperature should be maintained above 10 °C (50 °F) at the time of application.

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 5°C (40°F) :

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.

CLEAN UP

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

LOCAL RESTRICTIONS

Note that as a result of specific local regulations the declared data and recommended uses for this product may vary from country to country. Consult the local Product Data Sheet for exact product data and uses.

LEGAL NOTES

The information, and, in particular, the recommendations relating to the application and end-use of Sika products, are given in good faith based on Sika's current knowledge and experience of the products when properly stored, handled and applied under normal conditions in accordance with Sika's recommendations. In practice, the differences in materials, substrates and actual site conditions are such that no warranty in respect of merchantability or of fitness for a particular purpose, nor any liability arising out of any legal relationship whatsoever, can be inferred either from this information, or from any written recommendations, or from any other advice offered. The user of the product must test the product's suitability for the intended application and purpose. Sika reserves the right to change the properties of its products. The proprietary rights of third parties must be observed. All orders are accepted subject to our current terms of sale and delivery. Users must always refer to the most recent issue of the local Product Data Sheet for the product concerned, copies of which will be supplied on request.