BUILDING TRUST
CONSTRUIRE LA CONFIANCE

PRODUCT DATA SHEET

KING MS D1

PRE-PACKAGED SHOTCRETE MIX FOR DRY PROCESS APPLICATIONS

PRODUCT DESCRIPTION

KING MS D1 is a pre-blended, pre-packaged, shotcrete mix formulated for dry process applications. It contains Portland cement, silica fume, air-entraining admixture, blended aggregates, along with other carefully selected components, and presents greatly enhanced shooting characteristics and physical properties.

WHERE TO USE

- Rehabilitation of concrete bridges, dams, reservoirs, subway 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

Steel fibre reinforced (ST) & Macro-synthethic 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

- 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)

*For more information regarding the use of a corrosion inhibitor in conjunction with KING MS D1, please contact your Sika Canada Technical Representative.

OPTIONAL FEATURES & BENEFITS

ACCELERATOR LEVEL / SET-TIME / STRENGTH GAIN

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

KING MS D1 does not contain accelerator.
KING MS D1 X contains a level 1 dosage of accelerator.
KING MS D1 X2 contains a level 2 dosage of accelerator.
KING MS D1 X3 contains a level 3 dosage of accelerator.
Refer to Technical Data section for more detailed information.

SYNTHETIC FIBRE

- KING MS D1 SY
- Synthetic fibres reduce cracking caused by intrinsic stresses
- Type III synthetic fibre in accordance with ASTM C1116
- Grade FR Class I shotcrete in accordance with ASTM C1480

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

POTABLE WATER APPLICATION (PW)

Product meets the requirements of NSF/ANSI 61

STEEL FIBRE CONTENT (ST)

- Significantly increased load carrying capacity
- Significantly increased energy absorbing capacity (toughness)
- Significantly increased impact resistance
- Low permeability
- Reduction of cracking due to drying shrinkage

KING MS D1 STA contains a high dosage of steel fibre.
KING MS D1 STB contains a medium dosage of steel fibre.
KING MS D1 STC contains a low dosage of steel fibre.
KING MS D1 STD contains a very low dosage of steel fibre.

MACRO-SYNTHETHIC FIBRE CONTENT (MF)

- Significantly decreased wear on placing equipment and accessories when compared with steel fibres
- 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
- Improved adhesive and cohesive plastic properties
- Low permeability

KING MS D1 MFB contains a high dosage of macro-synthetic fibre.
KING MS D1 MFC contains a medium dosage of macro-synthetic fibre.
KING MS D1 MFD contains a low dosage of macro-synthetic fibre.

GRADATION

- By default KING MS D1,KING MS D1 ST and KING MS D1 MF is blended to meet ACI 506 “Guide to Shotcrete”, Table 1.1, Gradation No. 1
- KING MS D1 G2, KING MS D1 ST G2 and KING MS D1 MF G2 is blended to meet ACI 506 “Guide to Shotcrete”, Table 1.1, Gradation No. 2

EXAMPLES:
For KING MS D1 MF with a level 2 dosage of accelerator, a high dosage of macro-synthetic fibres and Gradation No. 1, the name of the product would be KING MS D1 X2 MFB.
For KING MS D1 with a level 3 dosage of accelerator, with synthetic fibres and Gradation No. 2, the name of the product would be
KING MS D1 X3 SY G2.
For KING MS D1 ST with a high dosage of steel fibres, a level 2 dosage of accelerator and Gradation No. 1, the name of the product would be KING MS D1 X2 STA.

PRODUCT INFORMATION

Packaging	30 kg (66 lb) triple-lined bags or 1 000 kg (2 205 lb) FIBC and polywrapped on wooden pallets. All KING products can be custom packaged to suit specific job requirements.
Shelf Life	12 months in original, unopened bag
Storage Conditions	Material should be stored in a dry, covered area, protected from the elements.
Compressive Strength	**ASTM C116 (MODIFIED)**

	KING MS D1 X	KING MS D1 X2	KING MS D1 X3
4 hours		1 MPa (150 psi)	5 MPa (725 psi)
8 hours	5 MPa (725 psi)	6 MPa (870 psi)	8 MPa (1 150 psi)
12 hours	7 MPa (1 015 psi)	8 MPa (1 150 psi)	10 MPa (1 500 psi)

ASTM C1604

	KING MS D1	KING MS D1 X	KING MS D1 X2	KING MS D1 X3
1 day	15 MPa (2 175 psi)	21 MPa (3 000 psi)	21 MPa (3 000 psi)	21 MPa (3 000 psi)
3 days	28 MPa (4 060 psi)	28 MPa (4 060 psi)	28 MPa (4 060 psi)	28 MPa (4 060 psi)
7 days	32 MPa (4 640 psi)	32 MPa (4 640 psi)	32 MPa (4 640 psi)	32 MPa (4 640 psi)
28 days	42 MPa (6 000 psi)	42 MPa (6 000 psi)	42 MPa (6 000 psi)	42 MPa (6 000 psi)

Modulus of Elasticity in Compression

MODULUS OF ELASTICITY **ASTM C469**

7 days	26.6 GPa (3.9 x 10^6 psi)
28 day	29.0 GPa (4.2 x 10^6 psi)

Tensile Strength in Flexure

FLEXURAL STRENGTH **ASTM C78**

	KING MS D1	KING MS D1 X	KING MS D1 X2	KING MS D1 X3
7 days	6.5 MPa (940 psi)	6.0 MPa (870 psi)	6.0 MPa (870 psi)	6.0 MPa (870 MPa)
28 days	7.5 MPa (1085 psi)	7.0 MPa (1 015 psi)	7.0 MPa (1 015 psi)	7.0 MPa (1 015 psi)

KING MS D1 MF & KING MS D1 ST

28 days	8.0 MPa (1160 psi)

Flexural rigidity

MACRO FIBRE OPTION **ASTM C1550**

KING MS D1 MFB

Peak applied load	Toughness as a function of flexure			
	10 mm	20 mm	30 mm	40 mm
25 kN (5 620 lbf)	> 150 J	> 250 J	> 350 J	> 450 J

KING MS D1 MFC

Peak applied load	Toughness as a function of flexure			
	10 mm	20 mm	30 mm	40 mm
20 kN (4 495 lbf)	> 80 J	> 125 J	> 250 J	> 350 J

KING MS D1 MFD

Peak applied load	Toughness as a function of flexure			
	10 mm	20 mm	30 mm	40 mm
15 kN (3 370 lbf)	> 50 J	> 80 J	> 150 J	> 275 J

STEEL FIBRE OPTION **ASTM C1550**

KING MS D1 STA

Peak applied load	Toughness as a function of flexure				
	5 mm	10 mm	20 mm	30 mm	40 mm
40 kN (8 992 lbf)	> 100 J	> 215 J	> 350 J	> 450 J	> 500 J

KING MS D1 STB

Peak applied load	Toughness as a function of flexure				
	5 mm	10 mm	20 mm	30 mm	40 mm
25 kN (5 620 lbf)	> 100 J	> 190 J	> 300 J	> 375 J	> 425 J

KING MS D1 STC

Peak applied load	Toughness as a function of flexure				
	5 mm	10 mm	20 mm	30 mm	40 mm
20 kN (4 496 lbf)	> 100 J	> 175 J	> 270 J	> 325 J	> 370 J

KING MS D1 STD

Peak applied load	Toughness as a function of flexure				
	5 mm	10 mm	20 mm	30 mm	40 mm
20 kN (4 496 lbf)	> 40 J	> 80 J	> 125 J	> 150 J	> 175 J

Tensile Strength

TENSILE BOND STRENGTH — **ASTM C1583**

7 days	2.2 MPa (320 psi)
28 days	2.9 MPa (420 psi)

Splitting Tensile Strength

7 days	3.8 MPa (550 psi)	**ASTM C496**
28 days	4.5 MPa (650 psi)	

Shear Adhesion Strength

BOND STRENGTH BY SLANT SHEAR (MODIFIED) — **ASTM C882**

7 days	21.1 MPa (3 060 psi)
28 days	23.0 MPa (3 335 psi)

Shrinkage

UNIAXAL DRYING SHRINKAGE — **ASTM C157**

	KING MS D1	KING MS D1 X	KING MS D1 X2	KING MS D1 X3
28 days	500 µm/m	600 µm/m	600 µm/m	600 µm/m
56 days	580 µm/m	650 µm/m	650µm/m	650 µm/m

Coefficient of Thermal Expansion

28 days	11.7 x 10^{-6} / °C (6.5 x 10^{-6} / °F	**CRD-C469**

Chloride Ion Diffusion Resistance

CHLORIDE ION PENETRABILITY — **ASTM C1202**

700 coulombs

Porosity

AIR CONTENT — **ASTM C457**

6 % ± 2 %

MAXIMUM AIR VOID SPACING FACTOR — **ASTM C457**

300 µm

BOILED ABSORPTION — **ASTM C642**

6.0 %

MAXIMUM VOLUME OF PERMEABLE VOIDS — **ASTM C642**

15.0 %

Freeze thaw resistance

KING MS D1	KING MS D1 X	KING MS D1 X2	KING MS D1 X3	ASTM C666
100 %	96 %	96 %	96 %	

Excellent durability factor

Salt Resistance

SALT SCALING RESISTANCE — ASTM C672

KING MS D1	KING MS D1 X	KING MS D1 X2	KING MS D1 X3
0.2 kg/m² (0.04 lb/ft²)	1.2 kg/m² (0.24 lb/ft²)	1.2 kg/m² (0.24 lb/ft²)	1.2 kg/m² (0.24 lb/ft²)

Yield

- 30 kg (66 lb) bag contains approximately 0.014 m³ (0.5 ft³)
- 1000 kg (2 205 lb) FIBC contains approximately 0.45 m³ (16.5 ft³)

Curing Time

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 seven (7) days. Alternatively, moist cure for a minimum period of 24 hours and apply a curing compound that complies with ASTM C309. 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*".

Setting Time

ASTM C1117	KING MS D1	KING MS D1 X	KING MS D1 X2	KING MS D1 X3
Initial	4 hours	1 hour	20 minutes	5 minutes
Final	6 hours	1 hour 10 minutes	30 minutes	10 minutes

BASIS OF PRODUCT DATA

Product properties are typically averages, obtained under laboratory conditions. Reasonable variations can be expected on-site due to local factors, including environment, preparation, application, curing and test methods.

**The following 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.

WHERE TO USE

- For adverse temperatures, follow ACI recommendations for Cold/Hot Weather Concreting.
- For cold temperature applications, use KING MS D1 X2 or KING MS D1 X3.
- 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.
- When using KING MS D1 MF or KING MS D1 ST, recommened minimum inside diameter of shotcrete hoses should be 50 mm (2 in).
- Use of a predampener in conjunction with dry-process, accelerated shotcrete is not recommended. Contact your Sika Technical Representative for more information.

ENVIRONMENT, HEALTH & SAFETY

NOTES ON INSTALLATION

OPTIMUM PERFORMANCE

- Product should not be applied when ambient substrate and material termperatures are below +5 °C (40 °F) or above +35 °C (95 °F).

SURFACE PREPARATION

Repair or rehabilitation: All surfaces to be in contact with KING MS D1 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 25 mm (1 inch) clearance behind any corroded reinforcing steel. The perimeter of the repair area should be saw-cut a minimum of 20 mm (¾ in). Clean the area to be repaired with potable water, leaving the concrete saturated but free of standing water (SSD).
Rock surfaces (KING MS D1 ST & KING MS D1 MF): All surfaces to be in contact with KING MS D1 ST and KING MS D1 MF 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).

APPLICATION

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

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 recommendations, or from any other advice offered. The information contained herein does not relieve the user of the products from testing them for the intended application and purpose. 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 or may be downloaded from our website at: www.sika.ca

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