

MS-D1 ST is a silica fume enhanced, steel fiber reinforced, pre-packaged shotcrete material for dry-process applications. This product is a pre-blended, pre-packaged, dry-process shotcrete material containing Portland cement, silica fume, steel fibers, air entraining admixture, blended aggregates and other carefully selected components. It has greatly enhanced post crack capacity and other physical properties.

## FEATURES & BENEFITS

- Significantly increased load carrying capacity
- Significantly increased energy absorbing capacity (toughness)
- Significantly increased impact resistance
- Improved adhesive and cohesive plastic properties
- Improved ability to build greater thicknesses in a single pass in both vertical and overhead orientations
- Improved resistance to water wash-out
- Low permeability
- Reduction of cracking due to drying shrinkage
- Designed with natural normal-density non-reactive aggregates to eliminate potential alkali-aggregate reactivity (AAR)
- Air-entrainment provides superior resistance to freeze-thaw cycling and salt-scaling resistance
- All KING products are manufactured using ISO 9001:2015 Certified Processes

## OPTIONAL FEATURES & BENEFITS

### STEEL FIBER CONTENT

- MS-D1 STA** contains a high dosage of steel fiber.
- MS-D1 STB** contains a medium dosage of steel fiber.
- MS-D1 STC** contains a low dosage of steel fiber.
- MS-D1 STD** contains a very low dosage of steel fiber.

See the Technical Data section for more detailed information.

### SET TIME/STRENGTH GAIN

- MS-D1 ST** does not contain accelerator.
- MS-D1 X ST** contains level 1 dosage of accelerator.
- MS-D1 X2 ST** contains level 2 dosage of accelerator.
- MS-D1 X3 ST** contains level 3 dosage of accelerator.

See the Technical Data section for more detailed information.

### GRADATION

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

### EXAMPLE:

For MS-D1 ST with a high dosage of steel fiber, a level 2 dosage of accelerator and Gradation No. 1, the name of the product would be MS-D1 X2 STA.

## USES

- 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.
- Use of a predampener in conjunction with dry-process, accelerated shotcrete is not recommended. Contact your local KING Technical Representative for more information.

## PROCEDURES

**Surface Preparation (Rock Surfaces):** All surfaces to be in contact with MS-D1 ST 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).

**Surface Preparation (Repair or Rehabilitation):** All surfaces to be in contact with MS-D1 ST 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 inch). Clean the area to be repaired with potable water, leaving the concrete saturated but free of standing water (SSD).

**Application:** Apply MS-D1 ST in accordance with the ACI 506 “Guide to Shotcrete” publication.

## CURING

Good curing conditions are beneficial to optimizing physical properties of MS-D1 ST. 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 rehabilitation applications, shotcrete 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.

## TECHNICAL DATA

The following data is representative of typical values achievable using proper application techniques as outlined in the ACI 506 “Guide to Shotcrete” publication. The data was obtained during project field tests and in-house shotcrete studies.

### ACCELERATOR LEVEL

	MS-D1 ST	MS-D1 X ST	MS-D1 X2 ST	MS-D1 X3 ST
<b>SET TIME*</b>				
<b>ASTM C 1117</b>				
<b>Initial</b>	4 hours	60 minutes	20 minutes	5 minutes
<b>Final</b>	6 hours	1 hour, 10 minutes	30 minutes	10 minutes

### COMPRESSIVE STRENGTH\* ASTM C 116 (MODIFIED)

<b>4 Hour</b>	-	-	1 MPa (150 psi)	5 MPa (725 psi)
<b>8 Hour</b>	-	5 MPa (725 psi)	6 MPa (870 psi)	8 MPa (1150 psi)
<b>12 Hour</b>	-	7 MPa (1015 psi)	8 MPa (1150 psi)	10 MPa (1500 psi)

## ACCELERATOR LEVEL

	MS-D1 ST	MS-D1 X ST	MS-D1 X2 ST	MS-D1 X3 ST
<b>COMPRESSIVE STRENGTH*</b> ASTM C 1604				
<b>1 Day</b>	15 MPa (2175 psi)	21 MPa (3000 psi)	21 MPa (3000 psi)	21 MPa (3000 psi)
<b>3 Day</b>	28 MPa (4060 psi)	28 MPa (4060 psi)	28 MPa (4060 psi)	28 MPa (4060 psi)
<b>7 Day</b>	32 MPa (4640 psi)	32 MPa (4640 psi)	32 MPa (4640 psi)	32 MPa (4640 psi)
<b>28 Day</b>	42 MPa (6000 psi)	42 MPa (6000 psi)	42 MPa (6000 psi)	42 MPa (6000 psi)

\*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.

## FLEXURAL STRENGTH ASTM C 78

28 Day 8.0 MPa (1160 psi)

## FLEXURAL PERFORMANCE ASTM C 1609

Dosage	First Peak Strength	F <sup>100</sup> <sub>600</sub>	F <sup>100</sup> <sub>400</sub>	F <sup>100</sup> <sub>150</sub>
<b>MS-D1 STA</b>	6.25 MPa (906 psi)	5.50 MPa (797 psi)	5.50 MPa (797 psi)	4.50 MPa (652 psi)
<b>MS-D1 STB</b>	5.50 MPa (797 psi)	3.00 MPa (435 psi)	3.00 MPa (435 psi)	2.75 MPa (398 psi)
<b>MS-D1 STC</b>	4.50 MPa (652 psi)	3.00 MPa (435 psi)	3.00 MPa (435 psi)	2.75 MPa (398 psi)
<b>MS-D1 STD</b>	4.00 MPa (580 psi)	2.50 MPa (362 psi)	2.00 MPa (290 psi)	1.00 MPa (145 psi)

## FLEXURAL TOUGHNESS ASTM C 1550

Dosage	Peak Applied Load	Toughness as a Function of Flexure				
		5 mm	10 mm	20 mm	30 mm	40 mm
<b>MS-D1 STA</b>	40 kN (8992 lbf)	>100J	>215J	>350J	>450J	>500J
<b>MS-D1 STB</b>	25 kN (5620 lbf)	>100J	>190J	>300J	>375J	>425J
<b>MS-D1 STC</b>	20 kN (4496 lbf)	>100J	>175J	>270J	>325J	>370J
<b>MS-D1 STD</b>	20 kN (4496 lbf)	>40J	>80J	>125J	>150J	>175J

## BOILED ABSORPTION ASTM C 642

6.0%

## MAXIMUM VOLUME OF PERMEABLE VOIDS ASTM C 642

14.0%

## OPTIMUM PERFORMANCE

- MS-D1 ST should not be applied when ambient, substrate and material temperatures are below 5 °C (40 °F) or above 35 °C (95 °F).
- 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.
- Recommended minimum inside diameter of shotcrete hoses should be 50 mm (2 inches).

## YIELD

1000 KG (2205 lb) bag contains approximately 0.45 m<sup>3</sup> (16.5 ft<sup>3</sup>).

## PACKAGING

MS-D1 ST is normally packaged in 1000 KG (2205 lb) bulk bags and polywrapped on wooden pallets. All KING products can be custom packaged to suit specific job requirements.

## STORAGE AND SHELF LIFE

Material should be stored in a dry, covered area, protected from the elements. Unopened bags have a shelf life of 12 months. Physical properties of MS-D1 ST may be adversely affected if material is stored in temperatures below 0 °C (32 °F). Material store below these temperatures should be allowed to warm to ambient underground temperatures before shooting.

## SAFETY PROCEDURES

MS-D1 ST contains Portland cement. Normal safety-wear such as rubber gloves, dust mask and safety glasses used to handle conventional cement based products should be worn. Safety Data Sheets are available upon request.

**Warranty:** This product is designed to meet the performance specifications outlined in this product data sheet. If the product is used in conditions for which it was not intended, or applied in a manner contrary to the written recommendations contained in the product data sheet, the product may not reach such performance specifications. The foregoing is in lieu of any other warranties, representations or conditions, expressed or implied, including, but not limited to, implied warranties or conditions of merchantable quality or fitness for particular purposes, and those arising by statute or otherwise in law or from a course of dealing or usage of trade. [REV.0010\_2458717.5]

### Head Office

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### Other Sites:

Boisbriand, Qc  
Brantford; Cambridge; Sudbury; Toronto(ON)

Edmonton (Alberta)  
Surrey (British Columbia)