



MasterFlow[®] Grouts

The Critical Link Between
Foundation and Turbine



Foundation Grout

The Critical Link

The latest technical developments in the construction of wind turbines are creating giant towers capable of producing higher levels of renewable energy. The foundations of these towers need to meet ever higher quality requirements while at the same time reducing construction periods. Wind power turbines are high, slender structures that are exposed to high dynamic wind loads and other service stresses.

The interaction of the machine with the load transferring components of the installation – tower, foundation and anchors – requires special attention in the design of a wind turbine. The most important loads acting on a wind turbine structure are:

- Axialload
- Rotation
- Vibration
- Bending
- Torsion

All these loads need to be transferred / absorbed by the grout connecting the tower to the foundation structure. A careful design and selection of the grouting material is therefore of utmost importance. Safe and durable installation of wind turbines largely depend on high performance building materials which connect the tower to its base / foundation.

Master Builders Solutions' specially developed ultra-high performance materials – **MasterFlow** grouts – meet all these requirements, have faster installation times and lead to long-term maintenance-free operation of onshore wind farms.



Safe and durable installations:

- Ultra-high early and ultimate strengths
- Excellent long term durability
- Volume stability for the life of the design



Opportunity for wider weather windows:

- MasterFlow grouts are applicable down to +35 °F
- Rapid strength development
- Placement in cold and hot environments



MasterFlow grouts are validated by many testing institutes:

- For grouting onshore wind turbines to the foundation



Improved risk management:

- Master Builders Solutions provides warranties
- Engineering and field staff support available



Cost effective installations:

- MasterFlow grouts can considerably reduce the overall installation time



Fast and easy installation:

- MasterFlow grouts safeguard on time project completion
- Wind turbines may even be connected to the grid earlier
- Quicker electricity production is possible





Master Builders Solutions

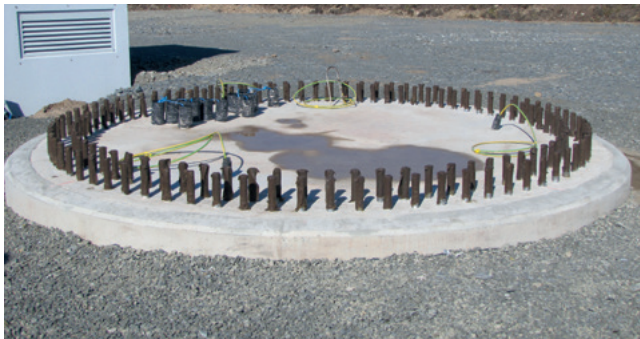
Building on partnerships. Our Master Builders Solutions experts find innovative and sustainable solutions to meet your specific construction needs. Our global experience and network help you to be successful – today and tomorrow.



Master Builders Solutions

The Master Builders Solutions brand brings all of its expertise together to create chemical solutions for new construction, maintenance, repair and renovation of structures. Master Builders Solutions is built on the experience gained from more than a century in the construction industry.

The know-how and experience of a global community of construction experts form the core of Master Builders Solutions. We combine the right elements from our portfolio to solve your specific construction challenges. We collaborate across areas of expertise and draw on the experience gained from countless construction projects worldwide. We leverage global Master Builders Solutions technologies, as well as our in-depth knowledge of local building needs, to develop innovations that help make you more successful and drive sustainable construction.



Admixture Systems for the best concrete mixes in foundations



Ultra-high performance MasterFlow grouts for wind turbines

MasterFlow® Cementitious Grouting Solutions for Onshore Wind

Product Selector

PRODUCT	DESCRIPTION	AGGREGATE TYPE	PERFORMANCE			APPLICATIONS		DYNAMIC LOADS			
			TEMP RANGE	FLOWABILITY			EXTENDED WORKING TIME	BASE PLATE & FOUNDATION GROUTING	GOOD	BETTER	BEST
				FLUID	FLOWABLE	PLASTIC					
MasterFlow 555	Nonshrink precision grout	Mineral	50 – 80° F (10 – 27° C)		•	•		•			
MasterFlow 928	Nonshrink precision grout with extended working time	Mineral	45 – 90° F (7 – 32° C)	•	•	•	•	•	•		
MasterFlow 4316	Ultra high strength, hybrid performance precision grout	Mineral	35 – 100° F (2 – 38° C)		•		•	•		•	

TECHNICAL DATA

MASTERFLOW

PROPERTY	555	928	4316
Compressive strength, psi (MPa)			
3 days			
Fluid	4,200 (29)	4,500 (31)	–
Flowable	4,500 (31)	5,000 (34)	10,900 (75.2)
Plastic	5,800 (40)	6,000 (41)	–
28 days			
Fluid	7,000 (48)	7,500 (52)	–
Flowable	7,500 (52)	8,000 (55)	16,700 (115.1)
Plastic	8,500 (59)	9,000 (62)	–
Working time, minutes	5 – 20	30 – 60	30 – 60

PACKAGING AND YIELD

PROPERTY	BAG / LBS (KG)	YIELD / FT ³ (M ³)
MasterFlow 555	50 (22.7)	0.42 (0.012)
MasterFlow 928	55 (25)	0.50 (0.014)
MasterFlow 4316	50 (22.7)	0.39 (0.011)

MasterFlow 555 Mineral-Aggregate Grout

A semi-fluid, non-shrink mineral-aggregate grout. It is ideally suited for grouting machines or plates requiring optimum load bearing support. MasterFlow 928 Extended Working Time Grout A hydraulic cement-based mineral aggregate non-shrink grout with extended working time. It is ideally suited for grouting machines or plates requiring precision load-bearing support. It can be placed from fluid to damp pack over a temperature range of 45 to 90° F (7 to 32° C).

MasterFlow 928 Mineral-Aggregate Grout

MasterFlow 928 grout is a hydraulic cement-based mineral aggregate non-shrink grout with extended working time. It is ideally suited for grouting machines or plates requiring precision load-bearing support. It can be placed from fluid to damp pack over a temperature range of 45 to 90° F (7 to 32° C).

MasterFlow 4316 High-Performance Grout

A unique grout that provides high early and ultimate compressive strengths over a wide variety of application and service temperatures. The superior performance of MasterFlow 4316 lies in its novel hydraulic cement binder with applied nanotechnology and premium mineral aggregates which, when mixed with water, produces a flowable and pumpable grout that can be installed in temperatures ranging from 35 to 100° F (2 to 38° C).



MasterFlow® Epoxy Grouting Solutions for Onshore Wind

Product Selector

PRODUCT	PERFORMANCE								APPLICATION					
	ELEVATED TEMP		FLOWABILITY		DYNAMIC LOAD	CHEMICAL RESISTANCE	LOW CREEP	HIGH BEARING	BASEPLATE FOUNDATION	NARROW CLEARANCE	ANCHOR BOLT			DEEP POUR (>6")
	GOOD	EXCELLENT	NORM	HIGH							SM	MED	LG	
MasterFlow 649		•		•	•	•	•	•	•	•		•	•	•

TECHNICAL DATA

PROPERTY MASTERFLOW 649

Compressive strength, psi (MPa)

Hours	55° F (13° C)	73° F (23° C)	90° F (32° C)
8	--	700 (5)	9,400 (65)
16	--	7,000 (48)	13,700 (96)
24	1,300 (9)	11,500 (81)	16,000 (112)
48	9,400 (65)	16,400 (115)	18,500 (130)
72	13,900 (96)	17,100 (118)	19,000 (134)
96	16,700 (115)	18,000 (124)	20,000 (141)

PACKAGING AND YIELD

PROPERTY PACKAGING YIELD FT³ (M³)

MasterFlow 649	PACKAGING	YIELD FT³ (M³)
57.4 lb unit		0.43 (0.012)
Resin	one 5.6 lb pail (2.5 kg)	
Hardener	one 1.87 lb bottle (0.85 kg)	
Aggregate	one 50 lb bag (22.7 kg)	
230 lb unit		1.73 (0.049)
Resin	one 22.3 lb pail (10.1 kg)	
Hardener	one 7.6 lb bottle (3.4 kg)	
Aggregate	four 50 lb bags (22.7 kg)	

MasterFlow 649 High-Flow Grout

A high-strength epoxy grouting material for support of heavy equipment. It ensures the proper transmission of static and dynamic loads to the equipment foundation. It offers high early and 7-day strengths for applications requiring fast turnaround as well as good chemical and crack resistance.

MasterFlow 647 Injection Resin

A modified epoxy resin grout, specially formulated for grouting cracks in structures and machinery foundations. Suitable for pressure injection of grouted baseplates beneath compressors, turbines, and other vibrating and rotating machinery.



MasterFlow 4316

For Onshore Wind Turbine Installations

Ultra High Strength Hybrid Cementitious Grout

MasterFlow 4316 is a unique grout that provides high early and ultimate compressive strengths over a wide variety of application and service temperatures. The superior performance of MasterFlow 4316 lies in its novel hydraulic cement binder with applied nanotechnology and premium mineral aggregates which, when mixed with water, produces a flowable and pumpable grout that can be installed in temperatures ranging from 35 to 100° F (2 to 38° C). It offers the strength of an epoxy with the ease of application of a cementitious grout.

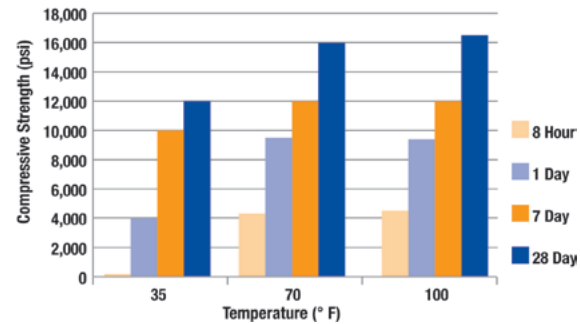


Concrete tower foundation



FEATURES

- High early compressive strength
 - 4,300 psi at 8 hours
 - 8,000 psi at 1 day
 - 16,000 psi ultimate strength
- 95% Effective Bearing Area
- Extremely dense material with proven fatigue resistance – durable
- Outstanding shrinkage, impact and vibration resistance
- Ability to place in cold weather (35° F / 2° C)
- In service temperatures up to 1000° F (538° C)
- Homogeneous, flowable and pumpable
- Application advantage – one component, easy mixing, placement and cleanup)



TEST DATA

PROPERTY	TEST METHOD REQUIREMENT			TEST METHOD
	35° F (2° C)	72° F (22° C)	100° F (38° C)	
Compressive strengths, psi (MPa)	ASTM C 109			
8 hours	none	–	4,300 (30)	–
12 hours	none	–	6,500 (44.8)	–
1 day	1,000 (7)	4,100 (28.3)	min. 8,000 (55.2)	min. 8,000 (55.2)
3 days	2,500 (17)	8,700 (60)	10,900 (75.2)	10,600 (73.1)
7 days	3,500 (24)	10,000(68.9)	min. 12,000 (82.7)	min. 12,000 (82.7)
28 days	5,000 (34)	11,900 (82)	16,700 (115.1)	17,000 (117.2)
Setting Time, min	ASTM C 191			
Initial	–	180	180	150
Final	–	220	210	180
Impact Resistance, Mass Loss, %	–	–	43	–
Fatigue	–	–	No deterioration after – 2,000,000 cycles	DNV-OS-C502-458 Loaded at 7,639 psi (52.7 MPa) at 5hz cycle rate
Effective Bearing Area	High - Greater than 95%			ASTM C 1339

MasterFlow 649

For Onshore Wind Turbine Installations

High Strength Epoxy Grout

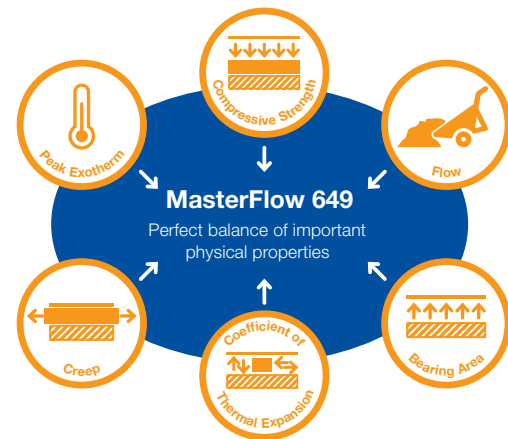
MasterFlow 649 is an epoxy resin-based precision grout used to secure critical equipment for proper alignment and transmission of static and dynamic loads. With carefully balanced physical properties and excellent resistance to chemical attack, elevated service temperatures, vibration and torque, MasterFlow 649 is formulated for easy installation, with good flow characteristics suitable for pouring or pumping. It also offers simple soap and water cleanup.



Concrete foundation ready to install turbine

FEATURES

- High Compressive Strength and Effective Bearing Area
- Excellent resistance to
 - Vibration and rotational torque
 - Creep
 - Chemical attack
 - Elevated service temperatures
- Formulated for easy installation
 - Good flow characteristics
 - Suitable for pouring or pumping
 - Soap and water cleanup



TEST DATA

PROPERTY	RESULTS	TEST METHOD																												
Compressive strength, psi (MPa), when cured at Cure rate, filled 6.25 : 1		ASTM C 579, modified																												
	<table border="1"> <thead> <tr> <th>Hours</th> <th>55° F (13° C)</th> <th>73° F (23° C)</th> <th>90° F (32° C)</th> </tr> </thead> <tbody> <tr> <td>8</td> <td>--</td> <td>700 (5)</td> <td>9,400 (65)</td> </tr> <tr> <td>16</td> <td>--</td> <td>7,000 (48)</td> <td>13,700 (96)</td> </tr> <tr> <td>24</td> <td>1,300 (9)</td> <td>11,500 (81)</td> <td>16,000 (112)</td> </tr> <tr> <td>48</td> <td>9,400 (65)</td> <td>16,400 (115)</td> <td>18,500 (130)</td> </tr> <tr> <td>72</td> <td>13,900 (96)</td> <td>17,100 (118)</td> <td>19,000 (134)</td> </tr> <tr> <td>96</td> <td>16,700 (115)</td> <td>18,000 (124)</td> <td>20,000 (141)</td> </tr> </tbody> </table>	Hours	55° F (13° C)	73° F (23° C)	90° F (32° C)	8	--	700 (5)	9,400 (65)	16	--	7,000 (48)	13,700 (96)	24	1,300 (9)	11,500 (81)	16,000 (112)	48	9,400 (65)	16,400 (115)	18,500 (130)	72	13,900 (96)	17,100 (118)	19,000 (134)	96	16,700 (115)	18,000 (124)	20,000 (141)	
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Tensile strength, psi (MPa) filled 6.25 : 1	2,300 (16)	ASTM C307																												
Flexural strength, psi (MPa) filled 6.25:1, cured 7 days at 73° F (23° C)	<table border="1"> <thead> <tr> <th>° F (° C)</th> <th>RESULTS</th> </tr> </thead> <tbody> <tr> <td>76 (24)</td> <td>4,600 (32)</td> </tr> <tr> <td>140 (60)</td> <td>4,200 (29)</td> </tr> <tr> <td>170 (77)</td> <td>2,100 (15)</td> </tr> </tbody> </table>	° F (° C)	RESULTS	76 (24)	4,600 (32)	140 (60)	4,200 (29)	170 (77)	2,100 (15)	ASTM C580																				
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76 (24)	4,600 (32)																													
140 (60)	4,200 (29)																													
170 (77)	2,100 (15)																													
Shrinkage, unrestrained linear in/in, filled 6.25:1	0.00065	ASTM C531																												
Impact strength,	Better than concrete																													



Master Builders Solutions

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The know-how and experience of a global community of MBCC Group construction experts form the core of Master Builders Solutions. We combine the right elements from our portfolio to solve your specific construction challenges. We collaborate across areas

of expertise and regions and draw on the experience gained from countless construction projects worldwide. We leverage global MBCC Group technologies, as well as our in-depth knowledge of local building needs, to develop innovations that help make you more successful and drive sustainable construction. The comprehensive portfolio under the Master Builders Solutions brand encompasses concrete admixtures, cement additives, chemical solutions for underground construction, waterproofing solutions, sealants, concrete repair and protection solutions, performance grouts and performance flooring solutions.

Master Builders Solutions products for the Construction Industry:

MasterAir®

Solutions for air-entrained concrete

MasterBrace®

Solutions for concrete strengthening

MasterCast®

Solutions for manufactured concrete product industry

MasterCem®

Solutions for cement manufacture

MasterEmaco®

Solutions for concrete repair

MasterFinish®

Solutions for formwork treatment

MasterFlow®

Solutions for precision grouting

MasterFiber®

Comprehensive solutions for fiber reinforced concrete

MasterGlenium®

Solutions for high-performance concrete

MasterInject®

Solutions for concrete injection

MasterKure®

Solutions for concrete curing

MasterLife®

Solutions for enhanced durability

MasterMatrix®

Advanced rheology control solutions for self-consolidating concrete

MasterPel®

Solutions for water tight concrete

MasterPolyheed®

Solutions for high-performance concrete

MasterPozzolith®

Solutions for water-reduced concrete

MasterProtect®

Solutions for concrete protection

MasterRheobuild®

Solutions for super-plasticized concrete

MasterRoc®

Solutions for underground construction

MasterSeal®

Solutions for waterproofing and sealing

MasterSet®

Solutions for retardation control

MasterSure®

Solutions for workability control

MasterTop®

Solutions for industrial and commercial floors

Ucrete®

Flooring solutions for harsh environments

Master Builders Solutions
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