



Onshore wind turbine installation & Grouting Meeting the Industry

New product introduction - MasterFlow 9400

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MasterFlow 9400

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MasterFlow 9400

Market demands



- » New generation of wind turbines more powerful with ever growing hub heights
- » Ever higher loads acting on the foundations, requiring superior designs
- » More rapid assembly of the towers, aiming for the lowest levelized cost of energy (LCoE)
- » Superior workability in a wide temperature range
 - Long working time in warm conditions
 - Rapid hardening even at cold temperatures
- » Certified materials, complying with the regulations of the different countries
- » Durable foundations
 - Maintenance free installations
 - Excellent fatigue resistance



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How to meet the market demands?



» Cost optimized foundation installation

- Reducing time for grouting works: reduce mixing operations, big bags instead of 25 kg bags, pumping instead of pouring
- Optimum use of weather windows: applications in cold and warm conditions
- Durable foundations: superior design using superior grouts

» Improved risk management

- Faster assembly of tower reducing the risk for early age defects
- Easier material installation: minimizing failures on site
- Improved quality of works and better Quality Assurance: on site Quality Control, intense Factory Production Control (FPC), confirmation of material quality from different production sites
- Certified product: independently tested and validated/certified by expert or recognized body
- Installation by specialist grouting contractors e.g. BASF LC's



MasterFlow 9400

New material especially developed for compatibility with the newest generation of onshore wind turbines

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The Chemical Company

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MasterFlow 9400

Ultra-high strength, cement based grout for onshore wind turbine installations

PRODUCT DESCRIPTION

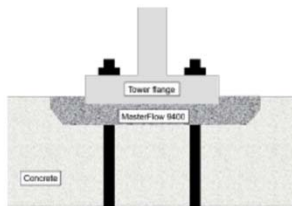
MasterFlow 9400 is a shrinkage compensated, cement based grout which when mixed with water, produces a homogeneous, flowable and pumpable grout with exceptionally high early and final strength and modulus. The product exhibits increased fatigue. Latest best binder packing models and applied nanotechnology produces a grout with superior technical performance, exceptional rheological properties, and uniquely, extended open times.

FIELDS OF APPLICATION

MasterFlow 9400 has been especially formulated for:

- Grouting of wind turbine installations, that are installed using pre-stressing techniques e.g. base plate grouting of onshore wind turbines
- Installations where excellent fatigue resistance is required
- Onshore turbines where ultra-high final strengths are required
- Grouting in a wide temperature range.
- Anchoring anchor bolts of wind turbine towers
- All void filling from 25mm to 300mm (under tower flange) where high strength, high modulus, high ductility is important

Contact the Technical Department of your local BASF Construction Chemicals office regarding any application or dimensions required not mentioned here.



FEATURES AND BENEFITS

- Ultra-high compressive strength: above highest class of EN206, i.e. > C100/115
- Ultra high modulus for exceptional stiffening properties.
- Excellent fatigue resistance.
- Quick return to service and removal of temporary supports due to high early strength build-up. ≥ 50 MPa @ 24hrs at 20 °C
- No segregation or bleeding to ensure consistent final physical performance and to prevent pump blockages.
- Extended pot life of ≥ 2 hours
- Can be pumped into complex areas or areas inaccessible to conventional grouting methods
- Dust reduced for ease of handling
- Cement based.
- Low chromate.

APPLICATION METHOD

MasterFlow 9400 has been especially formulated for use in specific applications. As such MasterFlow 9400 should be installed by experienced fully trained contractors.

Full application procedures are available on request.

Mixing:

Do not add cement, sand or other materials that affect the properties of this quality-controlled product. Mix full bags only. Use one or more mixers (forced action pan mixers are advised) to permit mixing and placing operations to proceed simultaneously without interruption. Mix with potable water only. Put most of the water required in the mixer and add slowly the grout material. Mix until a homogeneous mortar (≤ 4 minutes), add the remaining water and continue mixing for at least another 2 minutes until the required fluid or flowable consistency is obtained.

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Ultra-high strength, cement based grout for onshore wind turbine installations

TECHNICAL DATA	Unit	Values		
Density of mixture (EN 12696-2)	g/cm ³	Approx. 2.4		
Mixing water demand	litres	Approx. 1.75 / 25 kg powder at 20 °C (depending on temperature: 0.8 to 0.9%)		
Pot life of mixed material	hours	≥ 3		
Setting time	hours	≤ 7		
Air content (EN 12617-2)	%	≤ 4		
Application temperature (substrate and material)	°C	From +2 to +35		
Application thickness	mm	25 - 300		
Mechanical properties:				
Compressive strength (40 x 40 x 160 mm prisms - EN 12690)	N/mm ²	20 °C	30 °C	25 °C
- after 1 day		≥ 50	≥ 70	≥ 3
- after 7 days		≥ 100	≥ 95	≥ 75
- after 28 days		≥ 120	≥ 110	≥ 95
Characteristic compressive strength - 28 days (180 x 180 mm cubes - EN 12690-2)	N/mm ²	117		
Flexural strength (40 x 40 x 160 mm prisms - EN 12617-1)	N/mm ²	≥ 13		
Static modulus of elasticity (EN 12617-2)	GPa	Approx. 48		
Poisson ratio		0.18		
Capillary water absorption (EN 12607)	kg / m ² h ^{0.5}	≤ 0.05		
Drying shrinkage (EN 12617-2)	mm/m	≤ 0.3		
Crack resistance - Coudinho-ring		no cracking after 180 days		
Adhesion strength to concrete (EN 1542)	N/mm ²	≥ 2		
Pull-out strength of rebar (EN 12618 displacement at 75kN load)	mm	≤ 0.6		
Installation / Additional information				
Maximum grain size	mm	4		
Mixing time	minutes	Approximately 5		
Mixer type		e.g. pan mixer		
Application method		One continuous pour, from one side only		
Fire resistance (EN 13501-1)	class	A1 (f)		

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Independent testing – Quality assessment



» Excellent workability at wide temperature range

- Potlife ≥ 180 minutes at elevated temperatures
- Potlife ≥ 240 minutes at 20°C or below

» Low porosity

- Air content $< 4\%$
- Wet density of approx. 2400 kg/m³

» High early and final compressive strength

- ≥ 50 MPa after 24 h at 20°C
- $\geq C100/115$ (which is the highest strength class in EN206)
- Characteristic strength: 117 MPa (cylinders)

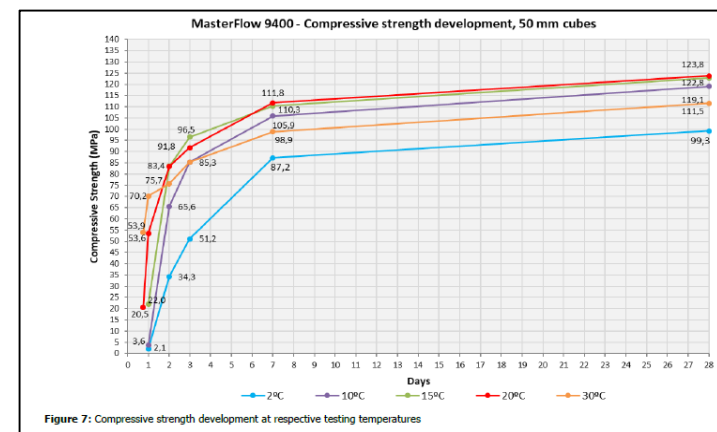
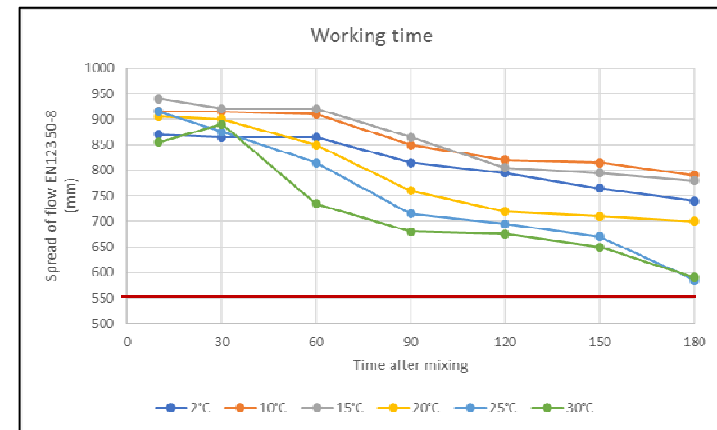


Figure 7: Compressive strength development at respective testing temperatures

MasterFlow 9400

Independent testing – Quality assessment



» High early strength

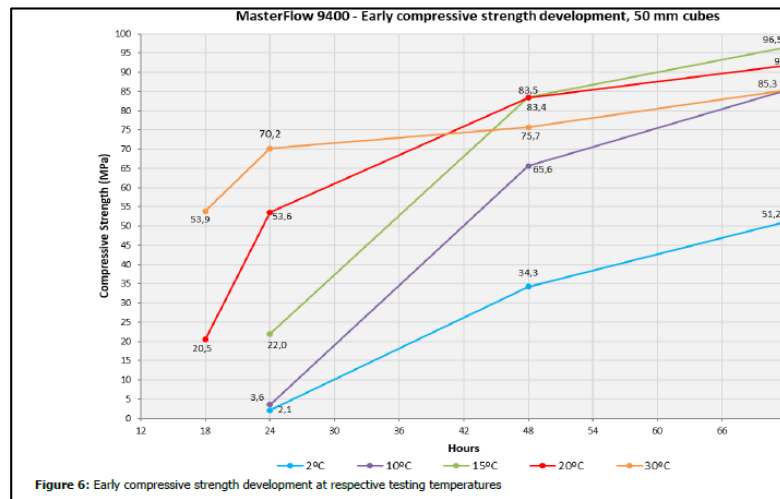


Figure 6: Early compressive strength development at respective testing temperatures

» High final strength

■ f_{ck} vs. f_{cm} for cylinders

Table 4.2: Test results of compressive strength on 150/300 mm cylinders

Test		Test method	Test temperature				
			2°C	10°C	15°C	20°C	30°C
Compressive strength (MPa)	28d	f_{cm}	98,1	117,1	116,4	118,5	109,5
		$f_{ck,cyl}$	94,8	115,0	115,3	117,2	104,5

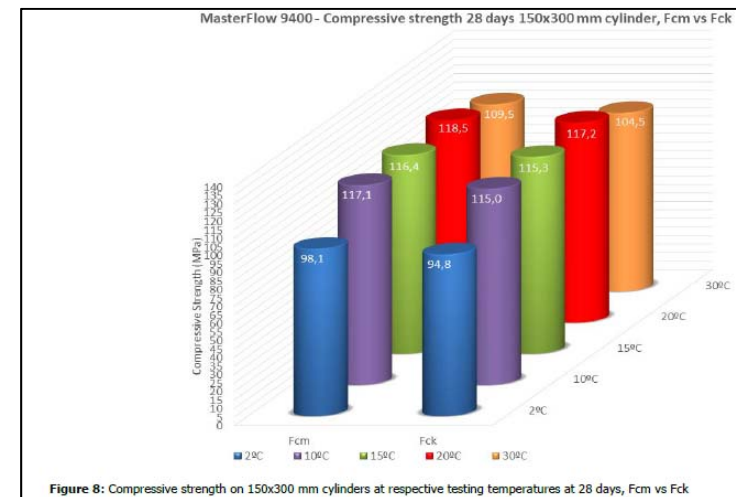


Figure 8: Compressive strength on 150x300 mm cylinders at respective testing temperatures at 28 days, Fcm vs Fck

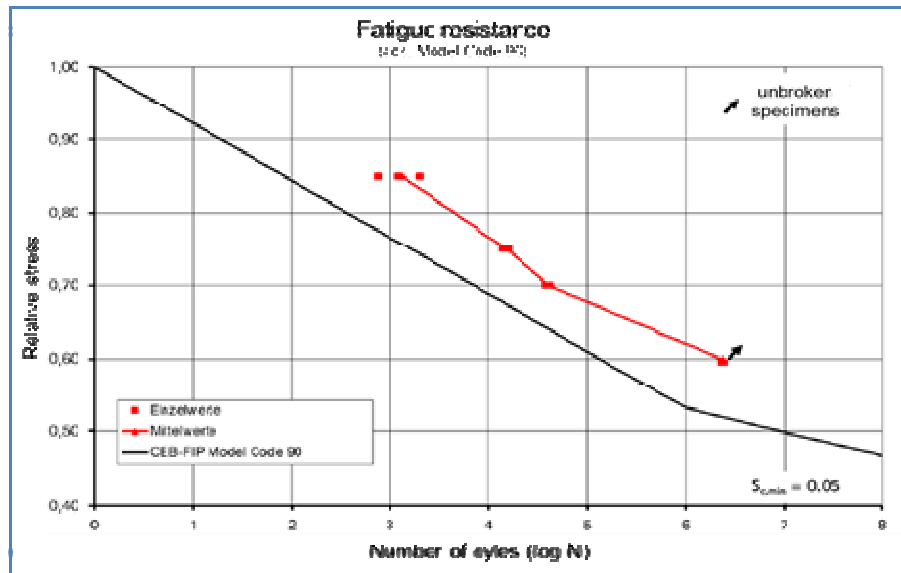
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Independent testing – Quality assessment

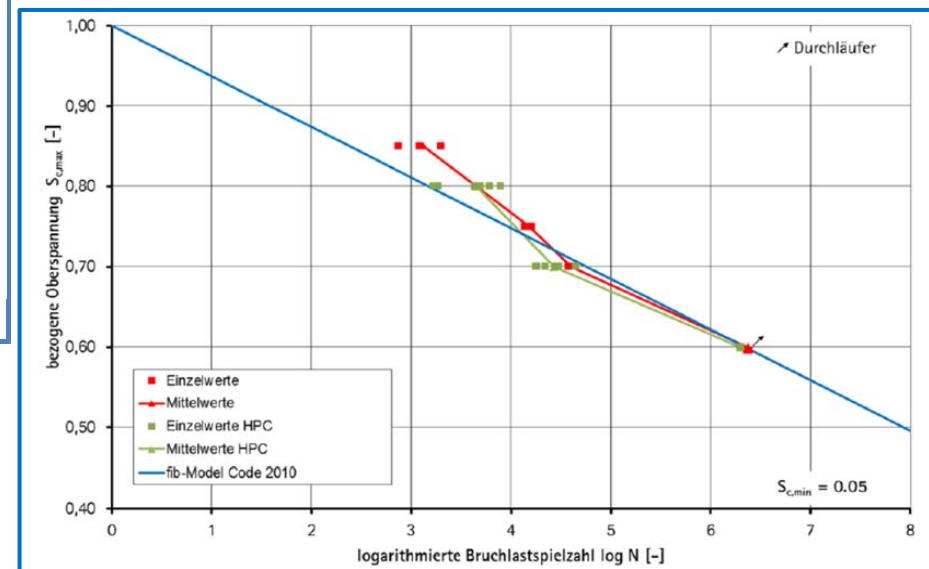


» Excellent fatigue resistance

acc. Model Code 1990



acc. Model Code 2010



MasterFlow 9400

Application method and Prototype application

» Mechanical mixing and placing

- Mixing with forced action pan mixers
- Pumping with worm or piston pumps

» MasterFlow 9400 available in

- 25 kg bags
- 500 kg big bags

» Large volume applications

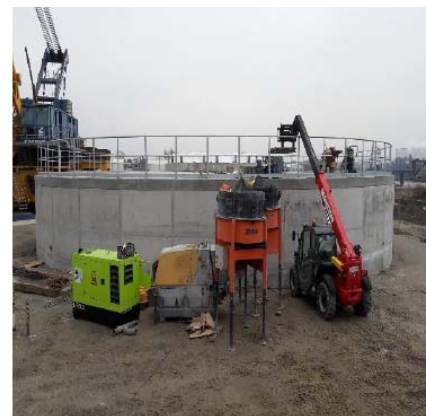
- Preferably using Putzmeister P715 or similar
- Using 300 to 500 liter mixers and big bags

» Reduced number of mixes

- Reduced QC frequency while ensuring constant quality
- Lower material loss

» Watch points e.g.

- Concrete surface preparation
- Free standing water
- Protection of pre-stressing bolts
- Adequate curing



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Application method and Prototype application

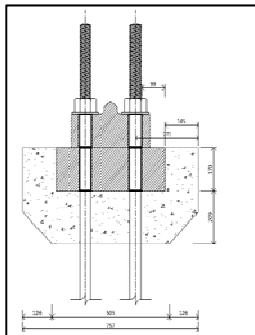


» First application using MasterFlow 9400

- Gamesa prototype: Bremerhaven, March 2017
- Turbine type: Adwen, 8 MW
- Installation by BASF LC - Azul
- 4 tons of MasterFlow 9400
- Intensive quality control on site
- Compressive strength under jobsite conditions (150 x 300 mm cylinders)



- After 39 h: 63.4 MPa
- After 45 h: 66.7 MPa
- After 64 h: 78.8 MPa
- After 28 d: 115.8 MPa



Ämtliche Materialprüfungsanstalt der Freien Hansestadt Bremen an der Fachhochschule der Stiftung Institut für Werkstofftechnik Bremen		
Investigation report 50170-17		Paul-Feller-Str. 1 28199 Bremen +49 (0) 421 / 50700 0 +49 (0) 421 / 50700 10 www.mpa-bremen.de info@mpa-bremen.de +49 (0) 421 / 50700 24 mailto:mpa@mpa-bremen.de
Customer	Achwin GmbH Am Lünebuck 156 27572 Bremerhaven	Report date: 24.04.2017 Number of pages: 9 After revision: none Date of order: 03.03.2017 Sample weight: 15.03.2017 Investigation start: 16.03.2017
Order No.	GR05-1017015062	
Subject of analysis	Casting mortar MasterFlow 9500 (BASF) Testing of strength properties	
Object	Wind turbine AD8-180 in Bremerhaven	
Task	Determination of flexural and compressive strength of prisms and compressive strength of cylinders. The tests started 39h, 45h, 64h, 7d and 28d after manufacturing.	
Sampling	The samples were taken in the responsibility of the customer. The MPA Bremen picked up the samples at building site on March 15, 2017.	
Storage	The samples used for analysis were destroyed, the remaining sample material will be stored for six weeks after the report is issued.	
<small>The results of this analysis are only valid in the original situation, in other cases the results are not valid. This report and its contents are not to be used for any other purpose than the one stated in the report. The results are not to be used for any other purpose than the one stated in the report. Verbleibende 100% der Probe sind zu den angegebenen Zeiten zu entnehmen. Die Probe ist zu den angegebenen Zeiten zu entnehmen. published in the Official Journal of the Free Hanseatic City of Bremen 1/98, No. 19, p. 45.</small>		



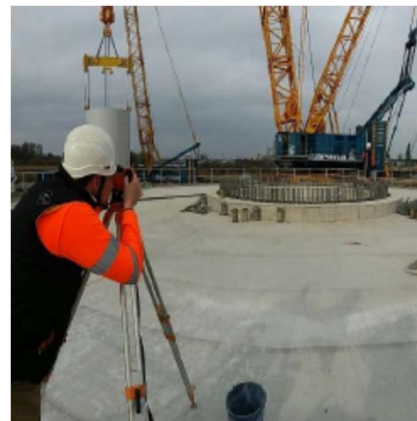
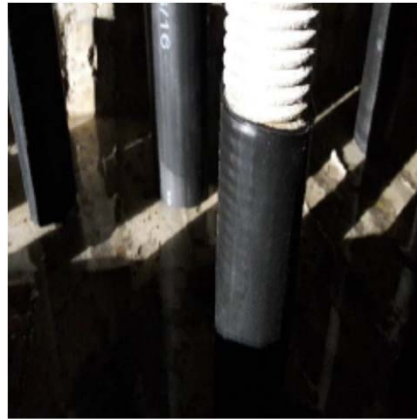
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Application method and Prototype application



» First application using MasterFlow 9400

- Impressions - © Azul



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Application method and Prototype application



» First application using MasterFlow 9400

- Impressions - © Azul



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Application method and Prototype application



» First application using MasterFlow 9400

- Impressions - © Azul



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Features – Advantages - Benefits



F eatures	A dvantages	B enefits
Grouting larger volumes in shorter period	<ul style="list-style-type: none"> - Faster grouting works - Shorter weather windows 	<ul style="list-style-type: none"> - Reduction of overall installation cost - Optimized assembly time
Rapid strength development	<ul style="list-style-type: none"> - Installation in short weather windows - Installation in cold conditions - Reduced risk of early age damage 	<ul style="list-style-type: none"> - Cost and time saving - Durable and secure foundation
Material available in 500 kg big bags	<ul style="list-style-type: none"> - Fewer individual mixes, minimizing failures on site - More focused quality control 	<ul style="list-style-type: none"> - Improved quality assurance - Lower cost for grouting works
Applicable from +2 to +35°C	<ul style="list-style-type: none"> - Long working time in warm conditions - High early strength even in cold weather 	<ul style="list-style-type: none"> - Optimized assembly time - Little to no weather downtime
High final strength	<ul style="list-style-type: none"> - Resists higher loads from ever growing turbines - Can be considered for smaller flange designs 	<ul style="list-style-type: none"> - Optimized / Lower cost of energy - Further design optimization possible
High fatigue resistance	<ul style="list-style-type: none"> - Resistant to dynamic loads 	<ul style="list-style-type: none"> - Excellent durability - Maintenance free installation
Independently validated by external laboratories	<ul style="list-style-type: none"> - Certified quality - Full material and process control 	<ul style="list-style-type: none"> - Improved risk management - Secure wind turbine installation

MasterFlow 9400

A perfect match of the market demands



Product benefits at a glance:



High fatigue resistance

Absorbing dynamic loads



Universal

Designed for use with majority of turbine types



Excellent durability

Guaranteed longterm electricity production



High early strength

Allows earlier pre-stressing of the anchor bolts



Secure installation

Application by BASF Licensed Contractors



Proven high quality

Evaluated by Gamesa and external laboratories



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