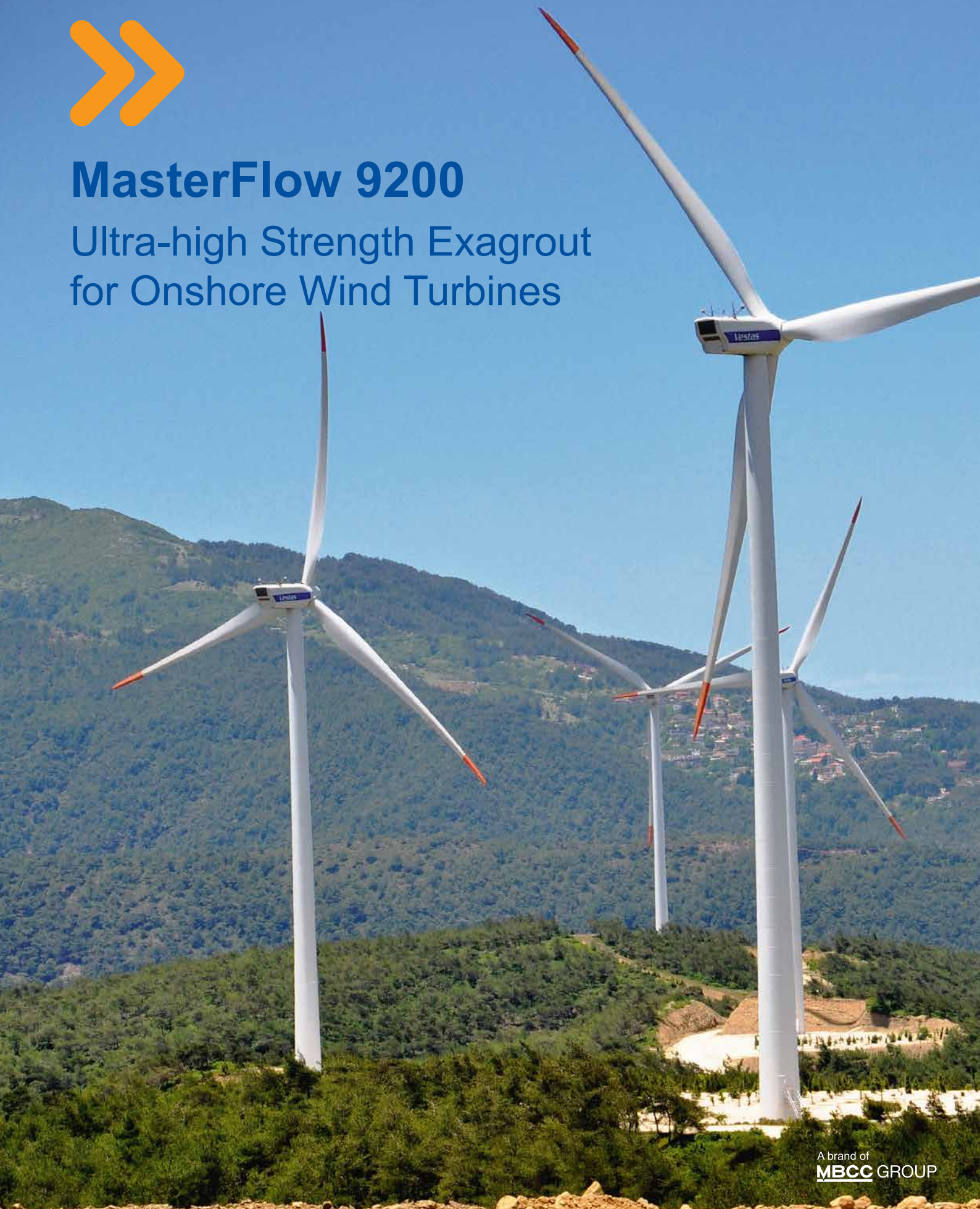




MasterFlow 9200

Ultra-high Strength ExagROUT
for Onshore Wind Turbines





Product at a Glance



“We need durable, high strength and fast hardening materials, that allow our turbines to be constructed in the shortest period possible. Master Builders Solutions delivers just that.”

Gunter Hecker, Purchasing Manager, Vestas Central Europe



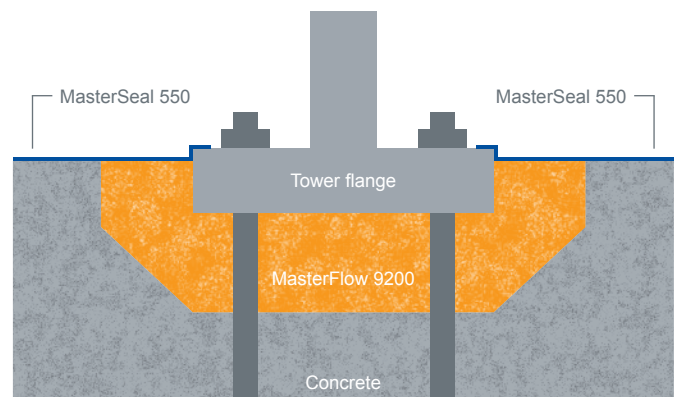
MasterFlow 9200: Turbine Specific Grout for Onshore Wind Turbines

MasterFlow 9200 is an ultra-high strength, fatigue resistant cement based ExagROUT for grouting onshore wind turbines – making wind energy projects more cost effective during installation, and more durable and secure over the entire lifetime of the wind farm. The product is especially developed to be compatible with all Vestas onshore wind turbine types.

MasterFlow 9200 is typically used in onshore installations built with the anchor cage design, and where the bottom flange of the turbine tower is to be grouted and connected to the concrete foundations.

The material has been especially formulated for onshore wind turbines:

- Grouting under the T-flanges of Vestas' wind turbine towers
- Grouting under harsh conditions and temperatures as low as 2 °C
- All void filling from 25 to 300 mm where excellent fatigue resistance, high early and final strength are required



Product benefits at a glance:



High fatigue resistance

Absorbing dynamic loads



Universal

Designed for use with all Vestas wind turbine types



Excellent durability

Guaranteeing longterm electricity production



High early strength

Allows earlier pre-stressing of the anchor bolts



Secure installation

Application by Master Builders Solutions' Licensed Contractors validated by Vestas



Proven high quality

Evaluated by Vestas Wind Systems and external laboratories



Excellent Compatibility with all Turbines

Meeting the very demanding specifications of the turbine supplier

MasterFlow 9200 has been developed by Master Builders Solutions experts especially to meet the highest requirements of Vestas Wind Systems.

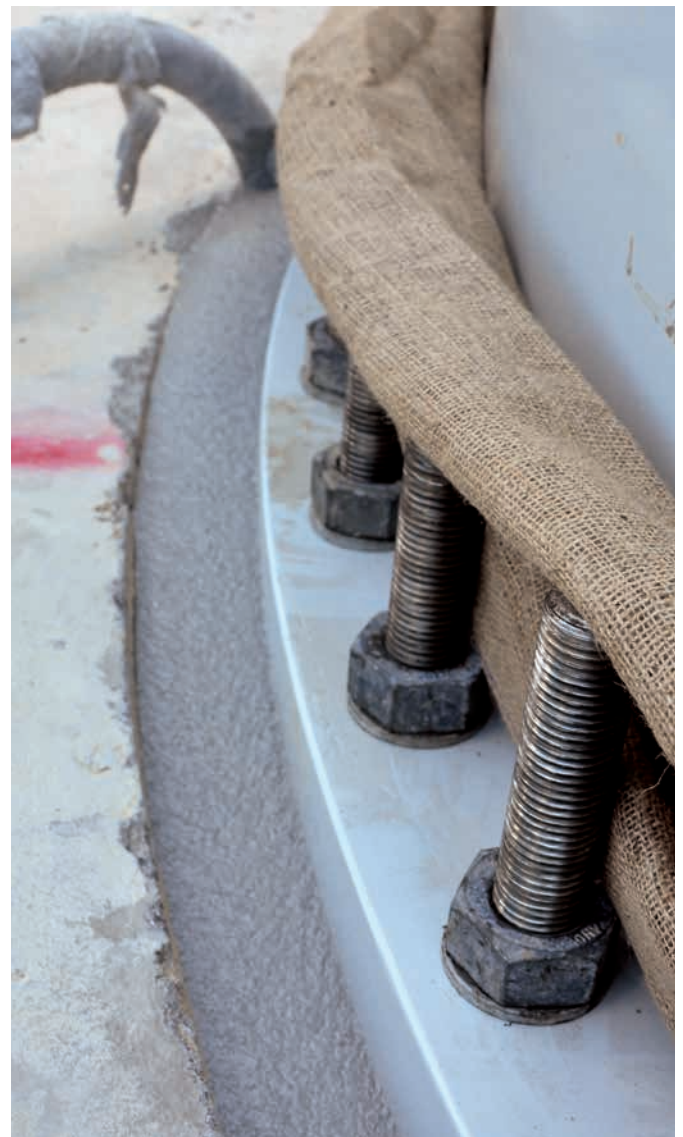
High fatigue resistance is of utmost importance to guarantee a trouble free operation over the expected 25 years lifetime of the wind farm. MasterFlow 9200 will ensure such excellent transfer of the dynamic loads that are occurring over the entire lifespan of a wind turbine installation.

To meet the requirements of the designers and wind turbine supplier, high early and final characteristic strengths are required for long term durability of the grout.

Application of MasterFlow 9200 by Licensed Contractors, which are even previously validated by Vestas Wind Systems, guarantees that the highly specialized MasterFlow 9200 is correctly installed. Mechanical properties are therefore also secured on the jobsite.



Our reference near Vredenburg in South Africa: West Coast One





Strength and Strength Development

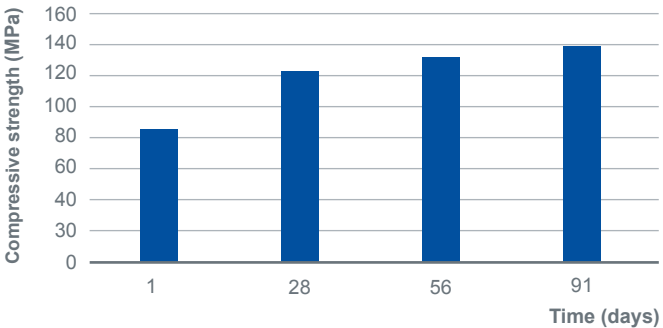
Even under harsh conditions and low temperatures

Compressive strength

The compressive strength of MasterFlow 9200 was tested using 150x300 mm cylinders. Figure 1 shows the strength measurements of MasterFlow 9200 tested at 20 °C after different ages. According the concrete norm EN 206, the material is classified in the highest possible strength class C100/115. In reality MasterFlow 9200 achieves a strength class C110/115.

Strength development at 20 °C

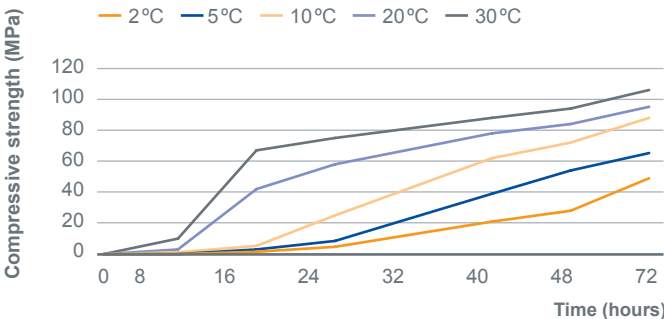
Figure 1



A minimum compressive strength is being considered in the installation procedures of Vestas Wind Systems. This to commence and proceed the installation of the tower components under the given environmental conditions, e.g. wind loads during erection of the tower. Furthermore, a safe and secure installation is only available when the anchor bolts of the tower are pre-stressed. Rapid strength development of the grout material is therefor of highest importance. Figure 2 shows the early strength development of MasterFlow 9200 at various temperatures between 2 °C and 30 °C, measured on 75 mm cubes.

Early strength development

Figure 2



Flexural strength – Tensile splitting strength – Modulus of elasticity

The flexural strength of MasterFlow 9200 was measured in accordance with EN 196-1 using 40x40x160 mm prisms, while the splitting tensile strength was determined according EN 12390-5 on 100x200 mm cylinders. The static modulus of elasticity was measured in line with EN 13412 using 100x200 mm cylinders . Results obtained after 28 days of curing are summarized in Table 1.

Table 1

Flexural strength (MPa)	Tensile splitting strength (MPa)	Static modulus of elasticity (GPa)
18	8	50



Outstanding Fatigue Resistance

Long term load transfer and control of cyclic loading

Fatigue resistance is the resistance to the progressive and localized structural damage that occurs when a material is subjected to cyclic loading. The nominal maximum stress values are less than the ultimate stress limit and may be below the yield stress limit of the Material.

Fatigue resistance

Fatigue occurs when a material is subjected to repeated loading and unloading. If the loads are above a certain threshold, microscopic cracks will begin to form. Eventually a crack will reach a critical size, and the structure will suddenly fracture.

Fatigue according fib-Model Code 2010

The uniaxial fatigue resistance testing of MasterFlow 9200 was part of an investigation at a renowned German test institute. Confirmation of the fatigue resistance of MasterFlow 9200 according fib-Model Code 2010 was based on that study.

For the investigation on MasterFlow 9200, the design and application of the grout has been reviewed in general accordance of EN 1992 and DIN 1045. And thus the same service conditions apply to MasterFlow 9200 as for ultra-high strength concrete.

The design criteria for the fatigue behavior of a material are based on CEB-FIP Model Code 90 in both norms mentioned before. It is therefore also assumed that these design criteria for fatigue apply also for the new fib-Model Code 2010. In addition, the applicability of the Wöhler-curves on MasterFlow 9200 has been evaluated.

This complete investigation allows to demonstrate the fatigue resistance of MasterFlow 9200 according the new fib-Model Code 2010.

Fatigue resistance of MasterFlow 9200

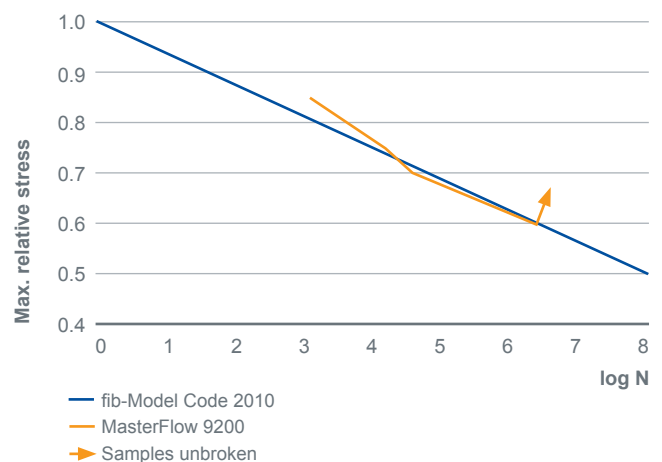
The behavior of MasterFlow 9200 under cyclic loading was studied using cylindrical specimens, 60 mm in diameter and 180 mm high. The grout material has been tested for fatigue resistance in air at 4 different load regimes (85 %, 75 %, 70 % and 60 % of the static compressive strength). Tests were performed at high frequency (10 Hz).

The observed number of cycles to failure in the tests under cyclic loading corresponds well with the prediction according fib-Model Code 2010 (Figure 3).

It can be concluded that for the confirmation of the fatigue resistance of MasterFlow 9200 the Wöhler-curves according fib-Model Code 2010 can be used. It can also be concluded that at any load condition, MasterFlow 9200 outperforms the requirements as given in CEB-FIP Model Code 90.

Fatigue resistance

Figure 3





Master Builders Solutions

The Master Builders Solutions brand brings all of our 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 regions and draw on the experience gained from countless construction projects worldwide. We leverage global 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, solutions for underground construction, waterproofing solutions, sealants, concrete repair & protection solutions, performance grouts, performance flooring solutions and solutions for on- and offshore wind energy.

Our comprehensive portfolio

- Concrete admixtures
- Cement additives
- Chemical solutions for underground construction
- Waterproofing solutions
- Sealants
- Concrete repair and protection solutions
- Performance grouts
- Wind turbine grouts
- Performance flooring solutions





Master Builders Solutions for the Construction Industry

MasterAir

Complete solutions for air entrained concrete

MasterBrace

Solutions for concrete strengthening

MasterCast

Solutions for the manufactured concrete product industry

MasterCem

Solutions for cement manufacture

MasterEase

Low viscosity for high performance concrete

MasterEmaco

Solutions for concrete repair

MasterFinish

Solutions for formwork treatment and surface improvement

MasterFlow

Solutions for precision grouting

MasterFiber

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MasterGlenium

Solutions for high performance concrete

MasterInject

Solutions for concrete injection

MasterKure

Solutions for concrete curing

MasterLife

Solutions for enhanced durability

MasterMatrix

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