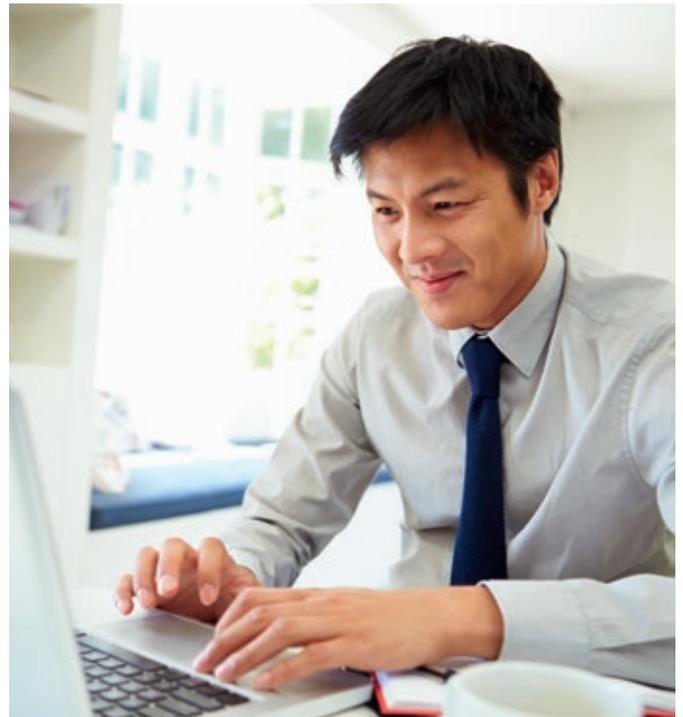




MasterFlow 648

Selecting the Best Epoxy Grout
Requires Consideration of the
Balance of Properties





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Equipment Around the World Supports Society

Epoxy grouts are used to secure critical equipment in industries that support and enable our basic civilization. Wherever there is machinery and equipment that needs to be reliably aligned and set, epoxy grouts are very often the preferred design solution.

Properly designed equipment foundations provide a safe, stable, secure base, ensuring alignment and long term service

Epoxy grouts are used in industries and applications because they provide a secure foundation, and maintain the precise alignment of dynamic equipment, enhancing operational efficiency and reliability: from energy and refining industry, water and waste treatment, production of cars to the manufacture of chemicals, pharmaceuticals and so much more. For the owner and operator, this translates into lower operating costs and improved equipment productivity. The main function of a foundation grout is to transfer load

and energy from the equipment down into the concrete foundation. Static and dynamic loads, vibration, impact and rotational torque must be transmitted from the equipment, through the grout and into the foundation to maintain the alignment and limit the wear and tear on the machinery parts.



Epoxy grouts used to secure:

- Compressors, generators, turbines, engines, pumps, fans, blowers and motors
- Rolling, stamping, grinding, crushing, boring, drawing, extruding and finishing mills and presses
- Crane rails, conveyors, gear and flued drives, sole plates
- Mixers, shredders, clarifiers, evaporators



Consider the Balance of Properties

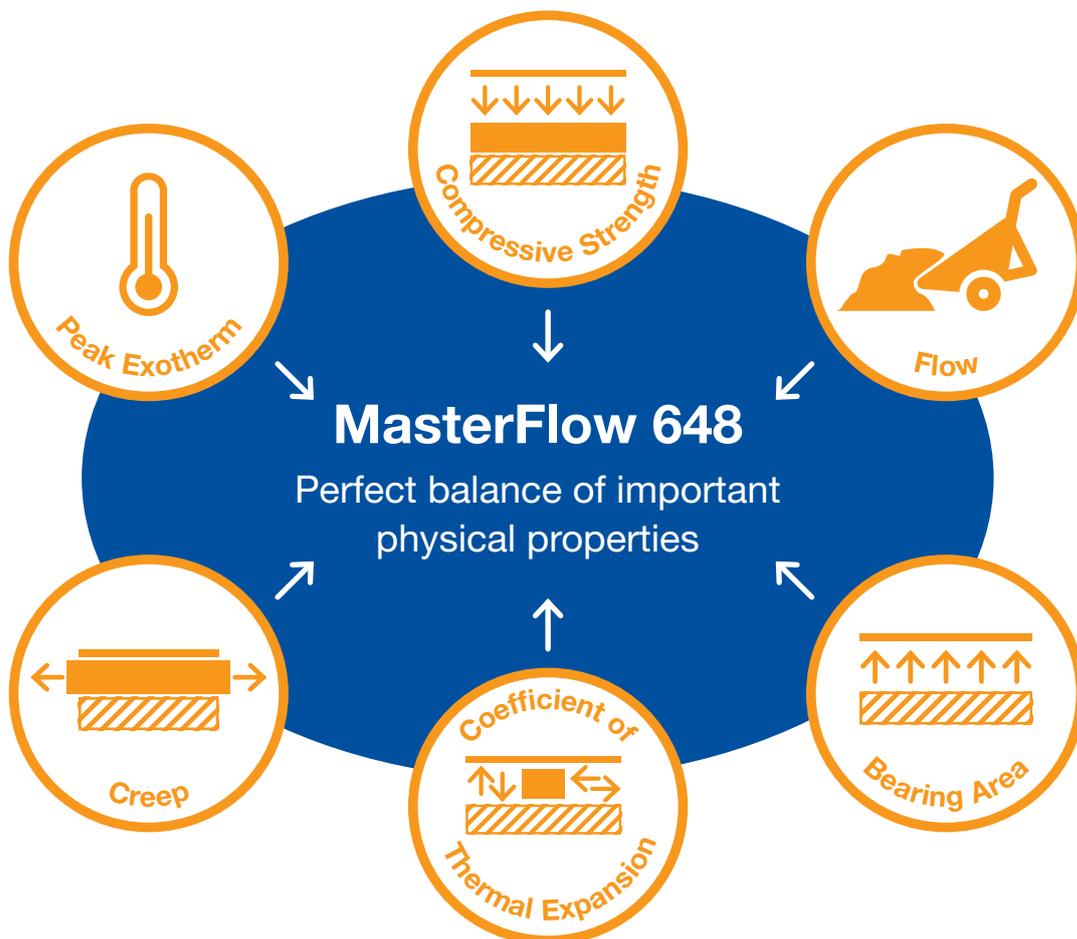
Physical performance

There are several relevant physical properties to be considered when selecting the appropriate epoxy grout for a specific application. Standards, protocols, guidelines and test methods can be used to evaluate how a material will perform and they are useful when comparing alternative products to understand similarities and differences.

Installation characteristics

Just as important as the physical properties of the grout are the installation characteristics. A grout that is too stiff, or viscous and cannot be placed effectively under the equipment will not be able to perform the intended task – to provide bearing support and transfer the loads. Conversely, some epoxy grouts that flow very quickly may ultimately fall short in their final in service performance.

MasterFlow 648 achieves its advanced performance properties by the combination of several distinct product features.





Compressive Strength – Important But Not Exclusive

Compressive strength is the most specified performance parameter. It is a measure of the maximum load the grout can withstand before failure, and it is a crucial aspect, since a grout needs to have a minimum compressive strength to support and transfer loads uniformly into the foundation.

Only one aspect to consider

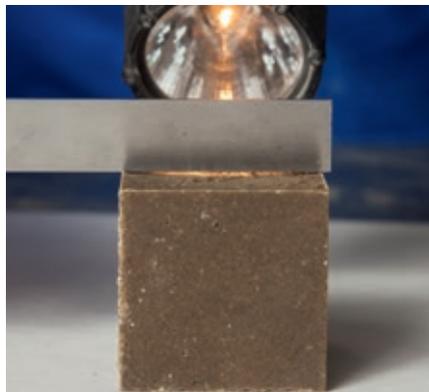
But it is only one aspect. Higher compressive strength doesn't necessarily mean better. Other properties must be

considered and specified to ensure the most durable and secure foundation.

API (American Petroleum Institute) 686, Recommended Practice for Machinery Installation and Installation Design, has identified 12,000 PSI (roughly 83 MPa) as an optimal compressive strength sufficient for most equipment used in heavy industrial applications.



Proper sample preparation is critical to ensure accurate compressive testing results. Include instructions in specification and installation documents.



Grout samples that are not complete square will not sit flush in the testing equipment, and therefore will yield inaccurate results.

Compressive strength testing

The protocol for testing compressive strength of polymer grout is detailed in ASTM C579, Method B, which uses 2" (50 mm) cubes. The test method is very clear, but to ensure true results, careful attention to the preparation of the test specimens must be taken. Specifications and installation documents should include detailed language to protect the integrity of the results.



Ductility

Ductility is a measure of a material's ability to undergo appreciable plastic deformation before fracture. When a grout cube is compressed using ASTM C579 Test Method B, it's useful to observe the sample after it is taken to failure. An epoxy grout with good ductility will still be a cube shape. A product that has poor ductility tends to shatter or fracture under the same load. A material that is too brittle and has poor ductility is more likely to experience premature failure. This can result increased risk and equipment maintenance.



Placeability – Successful Grout Installations Require a Workable Material

The ability of the material to properly flow across the full dimension of the equipment base is key to successful foundation grouting.

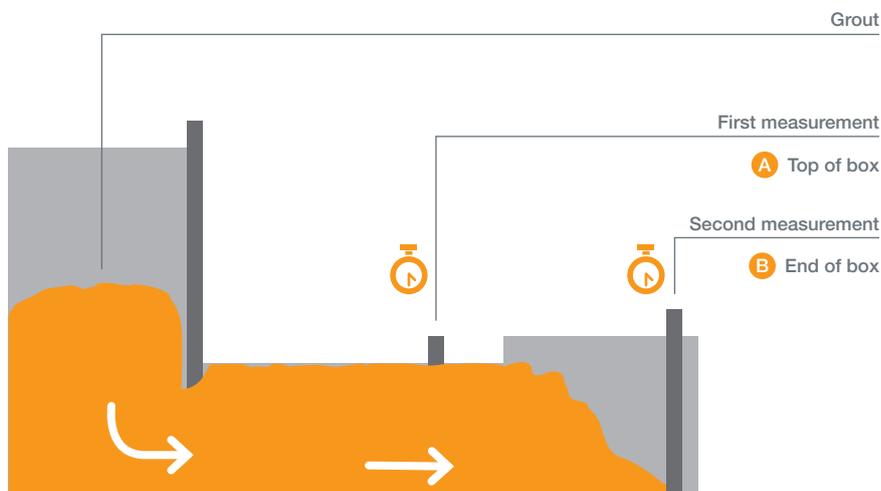
In applications with large equipment, where access is limited, the flow properties of the grout are crucial. Just as selecting a grout simply because it has a high compressive strength will not ensure proper machinery support, selecting a material simply because it has great flow is also not wise.

MasterFlow 648 provides full support

Therefore, a material with sufficient compressive strength for the intended application must also be capable of flowing under and across the full dimension of the equipment with sufficient consistency to provide complete, robust, reliable and safe support.

Measuring flow

Flow of epoxy grouts is measured using a flow box. For flow, a time measure is taken from two points on the flow box. The grout is poured into the headbox and left for five minutes, after which the gate is opened, allowing the grout to flow across the length of the box. A measurement is taken when the grout reaches the top of box, as shown in the illustration, and then again when the grouts make contact with end of the flow box.



Test method for flowability and bearing area

Both bearing area and flowability can be measured and reported using ASTM C1339, “Standard Test Method for Flowability and Bearing Area of Chemical-Resistant Polymer Machinery Grouts”.

For the measurement of flow rates a flow box is used.

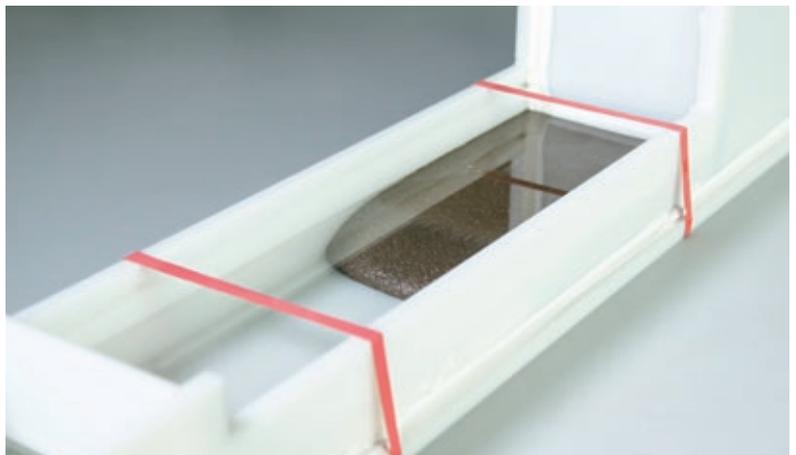
Increasing flow on the job site

Faced with a challenging installation, contractors in the field might remove one bag of aggregate from a mix to increase flow. This is acceptable, as long as the effects are understood. The grout material documentation from the manufacturer should include published independent test results at this lower aggregate content and specification documents should clearly state that a reduced aggregate/higher flow mix is acceptable.



Application temperature

It is important to note also that epoxy grout flow is significantly influenced by application temperature. Epoxy grouts will flow better in higher temperatures, so grout manufacturers who make available a quantitative measure for flow, as BASF does, should also indicate the testing temperature to provide a realistic indication of how the material will behave in the field.



Testing with flow boxes from the BASF labs.



Full Contact with Equipment for Secure Support

Ensuring sufficient grout flow is important, but that alone does not guarantee the grout is in full contact with what it will support. This is indicated by Effective Bearing Area, or EBA.

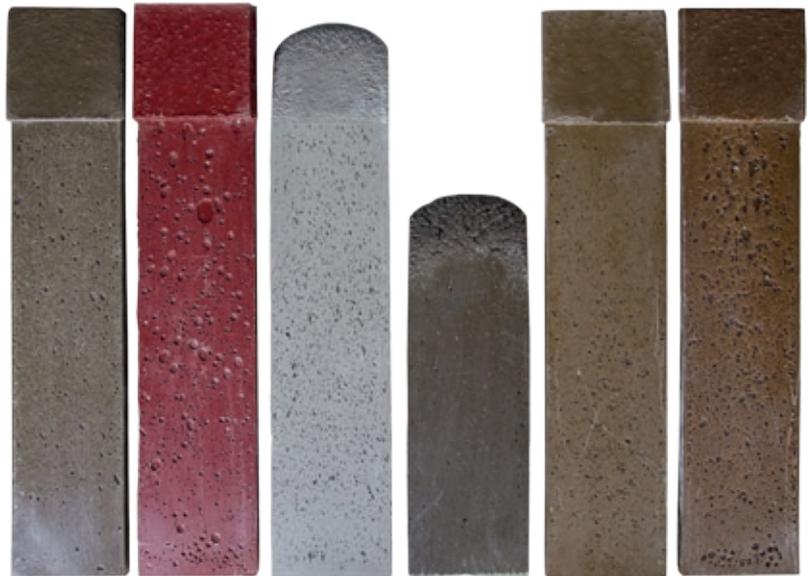
Balanced flow characteristics

Some grouts with very high flow characteristics have compromised on other performance attributes to achieve flowability. With some highly flowable grouts air migrates to the grout surface forming voids that lower the contact with the baseplate, jeopardizing bearing area, and in service performance.

A highly flowable grout may also have a higher polymer content and reduced aggregate. This will increase the likelihood that the grout will experience shrinkage and cracking, because aggregate acts as a heat sink and stabilizer, and less aggregate content reduces the ultimate strength of the cured grout foundation.

Reduced contact creates stress

When the grout is not in full contact, it is not able to provide full bearing support, creating additional stresses on the areas that are in contact with the machinery. This can eventually lead to misalignment, and unnecessary wear and tear that can create maintenance issues and even failures.



See videos of competitive testing at:
www.masterflow-648.basf.com



Data on flow properties

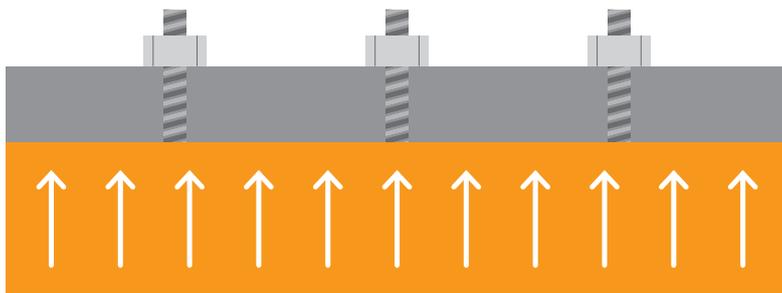
The ability of a grout to flow under the equipment it supports is critical. During independent testing some well known grout materials failed this test – unable to travel the length of the testing box. If data on flow properties is not presented on technical literature, contact the material manufacturer.

Measuring Effective Bearing Area

The second measurement that is derived from the ASTM C1339 testing is the percentage of grout that is in contact with the equipment. By obtaining maximum contact, we ensure that the grouted equipment is stable, and that any imposed loads are evenly distributed, extending the functional service life of equipment, the grout, and the foundation.

Three ranges of support

Once the flow measurements are complete, the grout in the flow box is allowed to harden. It is then removed from the flow box and the grout surface is abraded to open any air bubbles and voids that have formed between the grout and the baseplate. The determination of effective bearing area is a visual assessment to determine what percentage of the grout would actually be supporting the baseplate. ASTM C1339 defines three ranges of support: >85 % is high; 70–85 % is medium; <70 % is low.

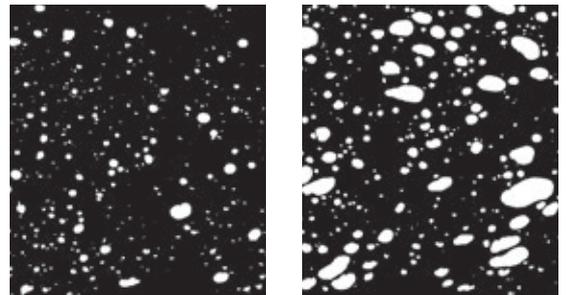


A stable foundation is required to ensure reliable support.



More quantifiable test method

In the ASTM C1339 test, the assessment of bearing area is purely subjective. At BASF we looked for something more scientific, more quantifiable. So we measure bearing area by removing the top plexiglas plate, wire brushing the grout sample, and then dusting the surface with white talc powder. We then photograph the surface, and scan the photograph. Using an off-the-shelf computer program that will display a histogram, we convert the scan to pure black and white, and use functionality within the program to calculate the percentage of light versus dark areas to arrive at a true and accurate percentage, or Effective Bearing Area.



For the measurement of the bearing area a computer analysis is used to generate quantitative results.

Best performance of any tested material

MasterFlow 648 consistently achieves high bearing area. In fact, in the lab trials the rating achieved was a solid 95 %, which was the best performance of any material tested.

95%



Expansion, Shrinkage and Creep – Supporting Equipment Long Term

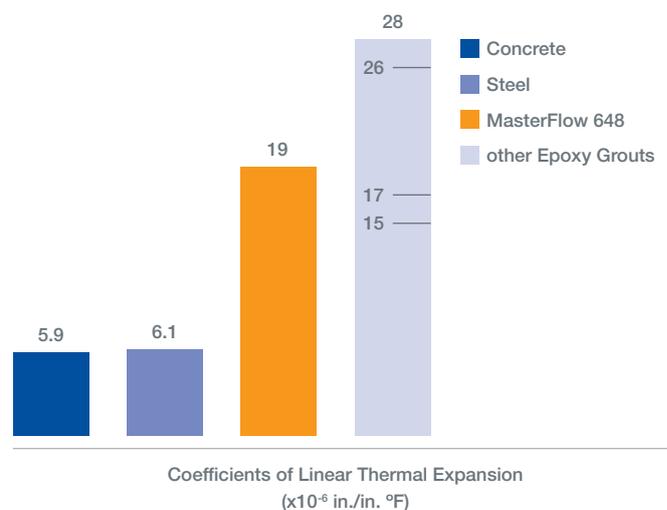
The polymer basis of epoxy formulations provide several benefits – such as vibration dampening, bond to baseplate, chemical resistance, and high early strength development for fast return to service. However after hardening, epoxy grouts can shrink or expand with changes in temperature – from day to night, summer to winter and from ambient to equipment operating temperatures.

Compatibility – Coefficient of Linear Thermal Expansion

Because epoxy grouts are placed between a concrete foundation and a steel baseplate or rails, it is important to understand how a particular grout is likely to behave in a realistic in-place environment at specific service temperatures. Coefficient of Linear Thermal Expansion measures the change in length of a material in response to temperature variations. The closer the values of the materials, the more compatible they will be, meaning they will expand and contract at a similar rate.

Concrete and steel have similar CTEs and are therefore compatible when used together. Many epoxy grouts, however, have much higher CTE's. This “dis-similarity” can lead to cracking, curling, and loss of bond, because changes in volume of the grout create stress at the bond line to the substrate. For optimal long term performance, specify a grout with a CTE as close as possible to the materials with which it will be in contact.

CTE's of different materials



Volume change testing and measurements

The Coefficient of Linear Thermal Expansion (CTE) is measured using ASTM C531. This test expresses the volume change of a material when a 1 degree F (0.5 degree C) increase or decrease in temperature is applied. The CTE result is expressed in units of inch per inch (or mm per mm) per degree of temperature change. To compare CTE between materials make sure that the temperature extremes used in the ASTM C531 testing are equivalent. Compressive creep for epoxy grouts is tested according to ASTM C1181, which measures the total compressive

deflection under a sustained load. Measurements are made at defined exposure periods, test temperatures and loading rates selected to simulate the in-service conditions a grout may experience. Most grout manufacturers report Creep data at 400 psi (2.8 MPa). BASF also includes Creep results for MasterFlow 648 at 600 psi (4.4 MPa) at 140 °F (60 °C) to provide additional performance data. As with CTE data, when evaluating Creep, comparisons between materials can only be made under the same load and temperature conditions.



Creep is a critical performance indicator

Creep, sometimes also called cold flow, is a time dependent measure of the dimensional change of an epoxy grout under constant load. It is a non-recoverable, permanent, long term deformation that a grout experiences over time.

A grout that has high creep can ultimately cause enough deflection in a baseplate to adversely effect machinery alignment, resulting in premature wear or failure of bearings and other rotating parts, increased equipment maintenance and replacement costs.

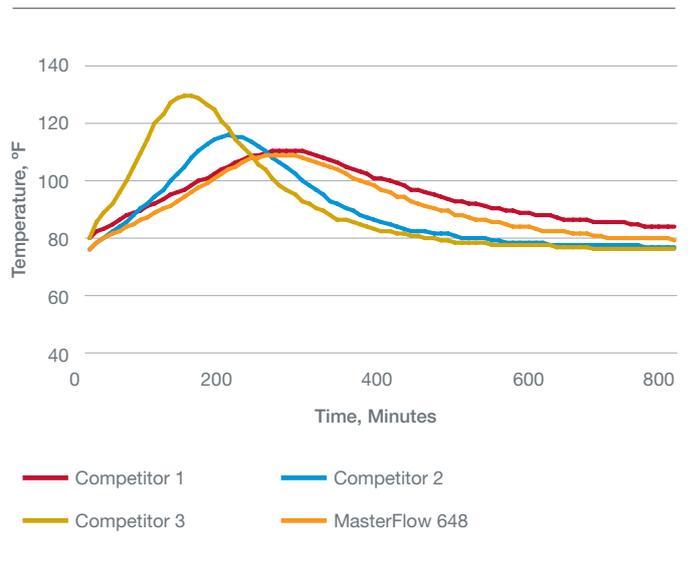
When specifying creep properties or comparing epoxy grout products, it is necessary to include the temperature and loading requirements. Simply reporting a creep value is meaningless without also knowing the temperature and load applied. Don't see creep data published for a grout? Ask the manufacturer. This is a critical performance indicator and should always be considered in specification documents.

Exotherm – gradual heat build protects final grout properties

All epoxy grouts exhibit a certain level of exothermic reaction. Peak exotherm is the maximum temperature that a grout reaches during cure. Differences between peak exotherm, foundation and ambient temperatures can produce localized stress around obstructions, such as anchor bolts, and at the foundation bond line. These stresses that lead to cracking.

An epoxy grout that exhibits a lower peak exotherm and a gradual temperature increase, rather than a rapid temperature spike, allows for dissipation of stresses that build up during the curing cycle.

Time vs temperature



Long service life and extended equipment protection

MasterFlow 648 was designed to minimize creep, ensuring long term support of machinery under sustained loads.





Safe, Clean, More Flexible: Installation Advantages of MasterFlow 648



It's clear to see that in order to perform as intended, the integrity of the grout in contact with the equipment must be ensured in terms of physical properties. MasterFlow 648 grout is formulated to meet and exceed of all of these criteria, and at the same time provides additional application and safety benefits to contractors and site owners to meet challenging installation scenarios.

Enhanced safety and jobsite cleanliness

The mixing of the epoxy resin and hardener needs to be done with care and accuracy, and adding the aggregate to the mix can create clouds of dust. A recent enhancement to the MasterFlow 648 epoxy grout is the introduction of low dusting aggregate. Worker safety and jobsite cleanliness is greatly improved.

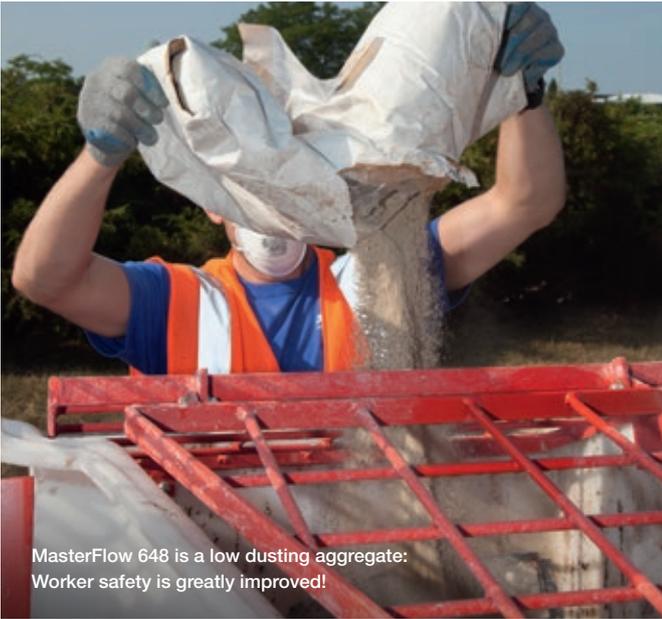
Many epoxy grouts require dangerous solvents for clean up, but MasterFlow 648 can be cleaned with just soap and water, reducing the need for additional chemicals on site and further enhancing worker and jobsite safety and efficiency.



Meeting the most challenging installation demands

MasterFlow 648 grout features superior flow characteristics, low dust generation and soap and water clean-up. It is formulated to be poured or pumped, and a high flow mix option offers placement flexibility.







Global Product Availability, Easy Access and Support



Global availability

MasterFlow epoxy grout is used to support critical equipment on every continent, in every corner of the world. Equipment manufacturers, owners, engineers, EPCs and specialty contractors can specify and install MasterFlow 648 grout with confidence, because it is a single formulation, available everywhere in the world. No need to wonder or worry about product availability and supply.



Training and support

On every continent, you will find BASF professionals who can provide product selection and specification assistance, technical guidance, documentation on proper placement, understanding of the relevant testing methods, as well as on site training of contractors to ensure proper mixing, application, placement and testing protocols are understood.



Detailed documentation

Online or in person, BASF provides detailed documentation to enable quality installation of MasterFlow 648 grout. Technical data guides, installation bulletins, and specification documents clearly outline the relevant engineering and contracting details.



Looking for data to support your next project,
visit www.masterflow-648.basf.com

No matter where

With MasterFlow 648 there is more material in contact with and supporting the precision equipment, and there are more dedicated people in all corners of the world ready to help on projects than with any other competitor in the market today.



Outperforming Other Epoxy Grouts

BASF has applied advanced chemistry to carefully balance the important physical properties and application behavior of MasterFlow 648 to ensure uncompromised, durable support.

MasterFlow 648 delivers high early and ultimate strength, and outperforms other epoxy grouts in equally-important critical criteria such as effective bearing area, shrinkage and creep; as well as elevated service temperatures and chemical exposure, while providing excellent flow and working time to facilitate proper placement.

- Enhanced flow, low dust, application alternatives – for safe installations requiring less labor
- High early and ultimate compressive strengths – earlier equipment commissioning or return to service
- Optimized load transfer and vibration dampening – protects equipment from unnecessary wear and tear
- Chemical resistance – durable even in harsh industrial environments



Responsible manufacturers of quality epoxy grout products will have data to offer and will welcome questions and discussions about the suitability of a grout for a particular application. They will understand the inter-relationship of the performance properties, and the limitation of the products. And most will have additional products in their portfolio specifically formulated to address challenging application environments.



Master Builders Solutions from BASF – Our comprehensive portfolio

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

Master Builders Solutions from BASF

The Master Builders Solutions brand brings all of BASF's 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 BASF 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 BASF 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.

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MasterAir®

Solutions for air-entrained concrete

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Solutions for concrete strengthening

MasterCast®

Solutions for manufactured concrete product industry

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